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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B03C 3/155, 3/38

A1

(11) International Publication Number: WO 98/20979

(43) International Publication Date: 22 May 1998 (22.05.98)

(21) International Application Number: PCT/CA97/00833

(22) International Filing Date: 7 November 1997 (07.11.97)

(30) Priority Data:
PCT/CA96/00730 8 November 1996 (08.11.96) WO
(34) Countries for which the regional or international application was filed: CA et al.
08/876,369 16 June 1997 (16.06.97) US

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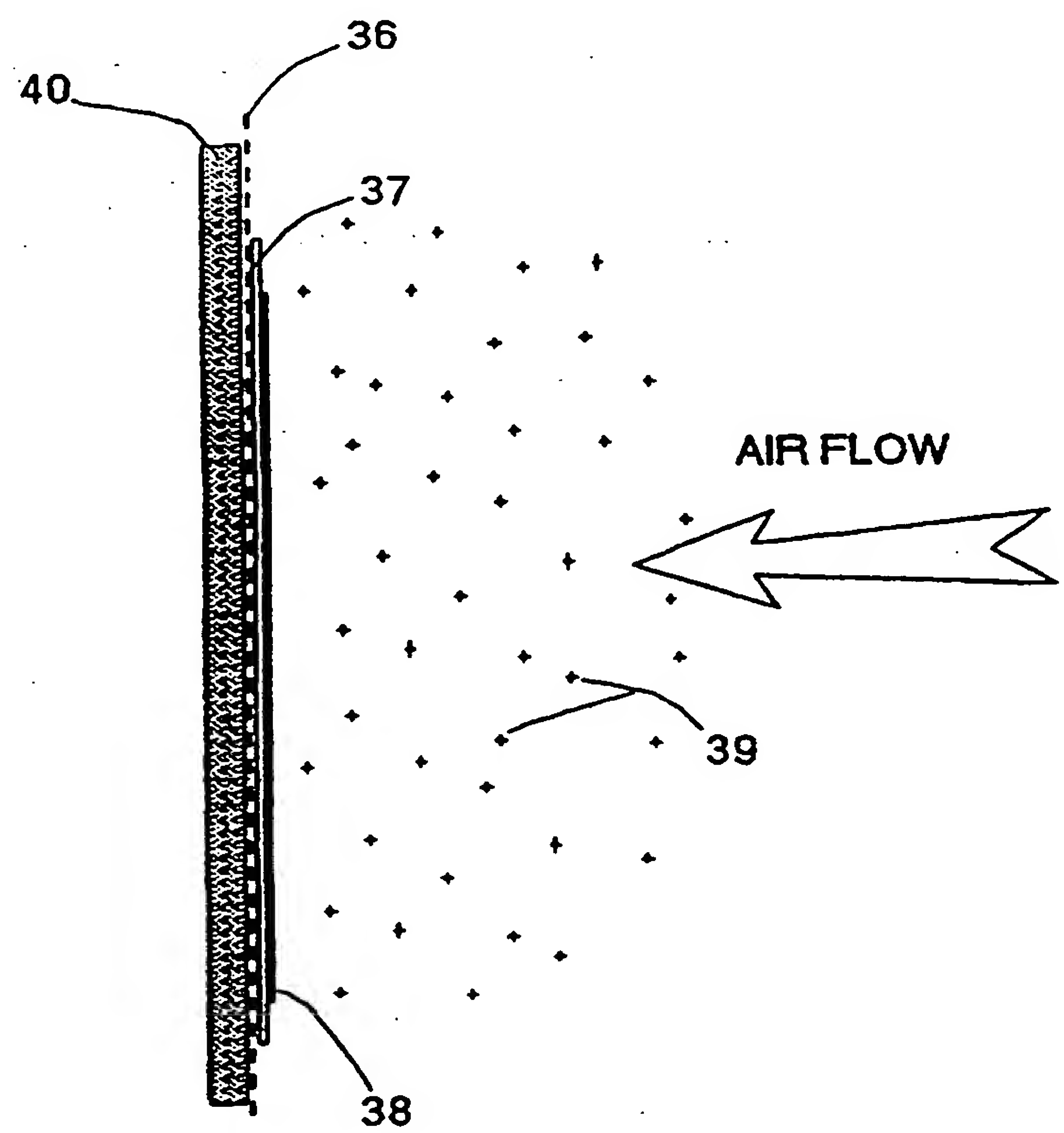
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: EXTERNALLY IONIZING AIR FILTER

(57) Abstract

An air filter assembly includes an ion source (38) positioned adjacent to the front face of an air filter to inject ions into the arriving air flow. The ions penetrate upstream sufficiently far to have ionized the air and charge particles before their arrival at the filter trapping medium. The ion source (38) is preferably sufficiently thin as to allow the filter with the ion source mounted thereon to be inserted into a filter slot in a duct of an air handling unit.



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TITLE: EXTERNALLY IONIZING AIR FILTER

FIELD OF THE INVENTION

This invention relates to air filters. In particular it relates to air filters whose performance is enhanced by ionizing the air carrying dust particles before such particles enter a trapping filter pad.

BACKGROUND TO THE INVENTION

Ionization has long been used to promote the removal of particulate matter from air. In an early United States patent No. 945,917 to Cotterell (1910) particulate-laden air is ionized and the charged particles thereby formed were collected on an electrically grounded surface.

Precipitator-type air filters of the type depicted in United States patent 2,593,869 to Fruth (1952) first ionize the particulate-carrying air, and then pass the air flow between oppositely charged parallel plates to which the particulates adhere. Such precipitating air cleaners are highly efficient when the plates are initially clean. However, performance drops off as the plates become covered with collected dust. Hence regular cleaning is required to maintain efficiency. This cleaning operation for precipitator-type air cleaners is awkward and costly to effect.

It is known to also trap airborne particles in disposable filter media such as granulated charcoal and fibrous matrices of glass wool and the like. The trapping capacity of such filter media can be enhanced by ionizing the air, and dust therein, before it enters the filter medium. United States patents Nos. 3,706,182 to Sargent (1972) and 4,244,710 to Burger (1981) both depict such an arrangement.

In both of these references ions are introduced into the air flow stream by ion emitters positioned at an upstream location in the air flow, at a spaced distance from the filter medium that is intended to remove ionized particles. A prior invention that also relies on the upstream release of ions into air ducts has been made by the present inventor, as represented in United States patent 5,518,531.

Apart from whether ionization is present, it is known that the trapping efficiency of a trapping medium of dielectric material such as glass can be enhanced by polarizing the medium under an electrical potential field having a high field gradient.

Two examples of prior art patents based on the polarization principle are U.S. Nos. 4,549,833 and No. 4,828,586, the contents of which are adopted herein by reference. The first patent describes a pair of outer hinged screens for enclosing a pair of glass fibre pads in a kind of a "sandwich" with a central grid located

therebetween. The central grid, made of coarse wire mesh that is on the order of 0.5 millimetres in diameter, is charged to around 7000 volts and the outer screens are grounded. The spacing between the charged screens is between two and five centimetres, producing an electric field gradient. This field gradient polarizes the non-conducting glass fibres rendering them more active in trapping dust particles, and more effective than non-polarized pads. This configuration does not generate ions to any significant extent.

An advantage of this polarized type of filter is that the accumulated dust is readily removed by exchanging the dust-laden fibre pads for fresh pads. However, polarized filter air cleaners are not as efficient as precipitator-type ionizing air cleaners. Considerable advantages can be achieved by combining features of both systems.

United States Patent No. 5,403,383 to Jaisinghani depicts an "Ionizing Field Electrically Enhanced Filter" wherein air passes through ionizing wires before reaching a separately-spaced pad of dielectric material that has a grounded electrode on its downstream side. To effect increased ionization Jaisinghani provides a further charged "control grid" positioned upstream from the ionizing wires in the air flow. This control grid helps provide field gradients that will create the desired degree of ionization at the ionizing wires. However, this upstream control grid

acts as an obstructing screen which limits the upstream diffusion of ions into the arriving air flow. Filter replacement does not disturb the ionizing wires which are separated from the filters and are permanently connected to the external supporting body of the overall system.

The present inventor has also obtained a U.S. Patent No. 5,573,577 issuing after the priority date herein for an improved grid for use in a polarizing filter that is made of a fibrous conducting filament with many protruding filament ends. These pointed ends create ionization in the air passing through the polarized trapping medium, enhancing filter efficiency. The grid is "sandwiched between two fibrous pads and two external grounded electrode screens.

A major concern in respect of all ionization-based air cleaners is to minimize the production of ozone. Ozone is offensive to some and can be injurious above certain levels. Any system that relies on ionization should also minimize the production of ozone.

The production of ozone is associated with power consumption i.e. the providing of a current flow under an applied voltage potential. The design and fabrication of high voltage supplies that deliver significant current is complex and costly. Great advantages arise when high voltage supplies are operated at low power levels. By avoiding the production of corona and associated ozone, the

advantages using a low power, high voltage supply become available.

Canadian Patent No. 1,294,226 discloses a low cost, low power, high voltage power supply that can be conveniently attached to a disposable air filter.

It is an object of this invention to provide for the incorporation of ionization into an air filtration system in a manner than is of minimal cost while being convenient to employ.

It is a further objective of this invention to provide for an ionizer which can be part of a filter and, if the filter is electronic with its own power supply, the ionizer can be connected to the filter's power supply. In this way, only one installation is required for one filter-ionizer combination.

The invention in its general form will first be described, and then its implementation in terms of specific embodiments will be detailed with reference to the drawings following hereafter. These embodiments are intended to demonstrate the principle of the invention, and the manner of its implementation. The invention in its broadest and more specific forms will then be further described, and defined, in each of the individual claims which conclude this Specification.

SUMMARY OF THE INVENTION

A principal feature of the present invention is that ions are introduced into an air stream to be filtered by providing an ion source that is located adjacent to the trapping medium through which the air stream will pass. Preferably, the ion source is actually carried and supported by the filter medium. The ion source in all cases is positioned so as to emit ions that are directed upstream, into the oncoming air flow, so that a zone of ionized air is formed within the air stream in advance of the trapping medium and the ion source. The objective is to produce a cloud of ions that will expand into the air flow in the upstream region, preferably without interference from ion-interfering obstacles, so that by the time the airflow arrives at the trapping medium, substantially all particulate matter carried therein will be ionized.

By positioning the ion source adjacent to the trapping medium and orienting the ion source to direct ions into the upstream region through which the air flow arrives a compact filtering assembly of improved efficiency can be created. The efficiency of the assembly can be further enhanced by providing for the trapping medium to be a polarizable substance and arranging for it to be polarized by an applied electrical potential field.

In a preferred variant, this invention provides for a thin ionizer which can be attached to the front of a

filter to ionize the air entering the filter and yet is thin enough to allow for the filter's insertion into a slot in an air cleaning apparatus. The ionizer preferably comprises one or multiple sharp-ended, ion-forming, charged electrodes each being exposed to a local field gradient about their ion emitting portions that is sufficiently intense so as to create ions in the air, but without creating an undue amount of ozone. The electrode, such as a needle or sharply pointed conducting fibres, may be supported by a thin, insulated holder which is attachable to a filter or may be bonded directly to a non-conducting surface portion of the filter medium. The ionizing element is connected to a high voltage power supply. The power supply may be part of a power supply of an electronic filter.

A particular phenomenon which supports the operation of this invention is that the ions so formed, whether positive or negative, expand away from their source under the influence of their mutual repulsion. Proximate to the source, an actual "ion wind" can be detected. By utilizing the combination of a properly shaped and positioned electrode, and an applied potential of adequate strength, the field gradient at the ion emitting location(s) on the electrode can be made sufficiently intense so as to create profuse numbers of ions. These ions form as a dense cloud which has an intense propensity to expand. This propensity to expand is sufficiently

strong to cause ions emitted from a properly positioned electrode to travel upstream, even against the current of an incoming air flow. As this ion cloud travels upstream it also expands laterally. This helps increase the prospects that most, if not all, of the particulate-laden air arriving at the filter medium will have become charged.

While an ion source positioned adjacent to a filter medium may, at low air velocities, be capable of ionizing most of the air arriving at the filter medium, as the air flow velocity increases, it may be thought that the extent to which the ion cloud will penetrate into, and expand across, the incoming air stream will be reduced. However, tests have shown that when the ion cloud is being deformed by a high velocity airflow, more ions are produced. This increase in ion production may be arising because of the removal of the "back pressure" that the ion cloud generates in respect of the emission of ions from the ion source. Thus, the ion cloud that forms upstream from the ion source resists truncation with increasing rates of air flow. In all events, when large filter areas are involved, multiple or elongate ion sources may be provided to ensure that ionization exists within most of the air arriving at the filter medium.

Various configurations may be employed to provide an ion source according to the invention. An insulated holder, preferably dome shaped, may be provided with a needle which serves as the ionizing element or ion source

mounted thereon. The needle may lie within a recess formed in the outer face of the holder to enable the filter on which the holder is attached to pass through a slot in an air handling system without interference. Or it may be resiliently mounted in an upright position to permit the same result. Equally, a sharp-edged, linear electrode that emits ions readily from a sharpened edge could be used in place of a needle.

In another variant, the ion source may be a piece of string with multiple, protruding, sharp fiber ends wherein the string has been rendered conductive. Normal cotton string dipped in a solution of graphite will suffice. The points of the string serve as ion emitters and produce minimal amounts of ozone.

The insulated holder provides insulation between the ionizing element and the adjacent filter which may have a conducting screen or conducting surface positioned on its outer side to serve as a field-gradient-inducing electrode in the case of a polarized filter. In the case of use of conducting string as the ion emitter, a strip of insulating film may underlie the string along its length.

This insulating strip is optional if the fibrous trapping medium to which it is attached is non-conducting and if the spacing to a counter electrode is sufficient to prevent arcing. If the trapping medium is thin, the insulative strip may be essential to prevent arcing. The adjacent screen, which serves as a counter electrode,

should have a potential that differs sufficiently from that applied to the ion emitting electrode in order to form the requisite field gradient at the ion emitter to effect emission of ions. Preferably, the screen is grounded.

The dimensions of the insulating holder are selected to provide for a spacing between the ionizing element and the counter electrode that ensures that the potential gradient around the ionizing element is high enough to produce ionization but not so high as to produce corona or arcing. For this purpose, care must be taken not to provide too great a charge collecting surface on the insulated holder. An excessively large non-conducing surface will accumulate charge which will dilute or reduce the intensity of the field gradient around the ionizing element, preventing ions from forming.

As an alternative to having a counter-electrode positioned downstream from the ion emitter on the filter pad, the counter-electrode may be provided by the frame assembly holding the filter media, or by metal ducting carrying the air to the filter assembly. This latter arrangement is normally preferred. However when the ion emitter is used in conjunction with a filter assembly having a grounded outer screen on either the upstream or downstream side of the sandwich combination of pads and screens, the field gradient at the ion emitting locations on the ion source will necessarily be effected, and the precautions mentioned above should be observed.

The foregoing summarizes the principal features of the invention and some of its optional aspects. The invention may be further understood by the description of the preferred embodiments, in conjunction with the drawings, which now follow.

SUMMARY OF THE FIGURES

Figures 1A and 1B show the insulated holder and ionizing element (a needle) in top view and cross-sectional elevation views respectively.

Figure 2 shows the ionizer in cross-sectional view, installed on the outside grounded screen of an electronic filter.

Figure 3 shows a typical installation of the ionizer on an electronic filter.

Figure 4 shows a typical installation of the ionizer on a passive, non-electronic filter with a counter electrode present.

Figure 4A shows a variation of Figure 4 without a counter electrode present.

Figure 5 shows an alternative construction of the ionizer using a bundle of upright conductive fibers instead of a needle.

Figure 6 shows a variant on Figure 5 wherein an upright needle is supported on a spring.

Figure 7 shows a thin ionizer arrangement where the counter electrode is part of the ionizing element holder.

Figure 8 shows an elongated ionizer using many ionizing elements.

Figures 9A and 9B show the same holder as Figure 8, but with a single long ionizing element.

Figure 10 shows the same ionizer as Figure 8, but with counter electrodes included as part of the ionizing element holder.

Figure 11 is a perspective view of a cartridge filter with an exterior ionizing element fixed directly over and on the surface of an exterior electrode screen by being mounted on insulating tape.

Figure 11A is an edge view of Figure 11.

Figure 12 is a perspective view of a variant of Figure 11 in which the ionizer is placed in front of a fibrous pad with the counter electrode being behind the pad.

Figure 12A is a cross-sectional side view of Figure 12.

Figure 13 shows a similar arrangement of thin ionizer as that of Figure 12 but with the insulating strips moved from directly behind the ionizer element to being positioned between the fibrous pad and the counter electrode.

Figure 13A is a cross-sectional side view of Figure 13.

Figure 14 is an exploded perspective view of a variant on the layout of the cartridge filter of Figure 12 wherein the trapping medium is conductive, as by being carbonized.

Figure 14A is an assembled perspective view of Figure 14.

Figure 15 is an exploded perspective view of a filter cartridge having non-conducting trapping media contained between two exterior screen electrodes and surmounted by an ionizing string electrode that is carried on an insulating strip.

Figure 15A is an assembled perspective view of Figure 15.

Figure 16 shows pictorially the filter assembly of Figure 3 being passed through a thin slot in the side of air ducting.

Figure 16A shows an alternate depiction to Figure 14 wherein the ionizing element is carried separately from the filter on an insulated arm for positioning in front of, and adjacent, the filter within the ducting.

Figure 17 is a graph showing the improved performance used by having an ionizing source according to the invention operating on the upstream side of a fiber pad.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In Figures 1 to 6, insulated holder 1 holds ionizing elements in the form of a needle 2 or fibres 15. The upper part of holder 1 is dome-shaped with a circular recession 3 formed in its outer, outwardly-directed, domed surface. Mounting protrusions 4 are present along the bottom of holder 1 for attachment to a supporting screen 6 or filter pad 18.

A protrusion 5 with a hole in it is provided to allow a bent portion of needle 2 to pass through to the other side of the holder 1. Needle 2 is bent at 90 degrees and the upper part of the needle lies in recess 3.

Figure 2 shows the ionizer installed on an outside screen 6, covering a filter pad 10 (shown in Figure 3). Mounting protrusions 4, 5 pass through the screen 6 to support the holder 1 on the screen 6. A thin, insulated coupling plate 7 with a hole in it fits over protrusion 5 on the side of the screen 6 remote from the needle 2 in order to provide insulation around the junction of needle 2 with wire 8. Insulated wire 8 is attached at one end to needle 2 and at the other end to a common high voltage power supply 11 (shown in Figure 3). Insulating sealant material 9 like "hot glue" or silicon rubber, etc. preferably insulates the needle-to-wire connection.

Figure 3 shows the ionizer unit installed on an electronic filter 10 in which the metallic screen 6, on its outer side serves as a counter electrode by being connected

to a high voltage power supply 11 included as an integral part of the filter 10. Insulated wire 8 passing behind the screen 6 connects the needle 2 to the power supply 11 to provide the needle 2 with a high potential. The metal screen 6 is preferably grounded. Alternately, the ionizing element 2 may be grounded and the screen 6 may have an elevated potential.

Figure 4 shows the ionizer installed on a passive filter 12 which has no screen covering its outside surface and no high voltage power supply of its own. In this case, a circular, conductive counter-electrode 13 may optionally be attached or glued to the non-conducting, passive filter's 12 outer, rear surface and ionizer 1 than attached to the filter pad 18 through the counter electrode 13. Counter -electrode 13 is connected to the high voltage terminal of power supply 14 and acts in the same way as the screen 6 of the filter shown in Figure 3. This electrode 13 may be a screen, a metal ring and it may be part of needle holder 1.

As an alternative to providing a dedicated counter electrode component in the form of screen 13, conducting parts of the support for air filter 12 or surrounding ducting 30 (as in Figure 16) or another electrical ground may serve as the counter electrode. Figure 4A shows this arrangement where 13A is a ground connection respecting a duct or electrical ground, etc.

The objective in all cases is to create the requisite field gradient for ionization at the ion-forming locations on the ion source 2,15.

Geometrically, it has been found that in an electronic, polarized filter with grounded outer screens 6 and a central charged, grid-electrode sandwiched between two-2 cm thick glass fibre pads and charged to 7000+ volts, the ionizer may be connected to and provided directly with the central electrode's potential. In such case, the holder 1 has been made of polyproplene or similar plastic and may be kept to a diameter of preferably 3-8 cm. The needle 2 was located in a 1 mm recess formed in a holder 1 which is 3 mm thick.

Use of a larger diameter holder 1 with a needle 2 was found to reduce the ion-generating capacity of the system. Use of a separate potential source of +10,000 volts with a 4 cm diameter holder 1 was found to produce copious ions without undue corona or ozone being generated.

The ions generated had sufficient mobility due to their mutual repulsion to travel upstream against an incoming flow of air arriving at a speed of up to 500 feet per minute.

Figure 5 shows another alternative structure where the ionizing element is a bundle of elastically resilient, fine, conducting fibres 15 with sharply pointed ends. The fibres 15 can flex and do not interfere with insertion of the filter into a slot 30 (see Figure 16). A

conducting support sleeve 16 holds fibres 15 upright above the holder 1 with the sleeve 16 being within the recess 3. A hollow, downwardly-directed protrusion 17 extending below holder 1 (similar to the pin-carrying protrusion 5) can be used to support the sleeve 16. In this arrangement, however, protrusion 17 is located in the centre of holder 1.

In Figure 6 a needle 2 held by a spring 26 replaces the fibres 15 and sleeve 16 as the ionizing element. An enlarged central protrusion 31 and circular locking ring 32 of insulative material fasten the holder 1 to screen 6. Alternately, the holder 1 may be attached to a plate of insulative material which is part of an arm 35 (shown in Figure 16) for positioning the ion source in front of a filter pad 18. Central protrusion 31 acts as an insulator to prevent the risk of arcing between the wire 8 and screen 6 and thus insulator 7 (Figures 2 and 5) is not needed. Screw 33 connects wire 8 to spring 26. Spring 26 is removably attached to screw 33 by unthreading from above for safety when handling the unit. Also, holder 1 has indentations 34 (preferably four) on the periphery to enable the needle 2 to recline into one of these indentations when the filter/ionizer combination is inserted into a slot in a duct 30 without damaging the spring 26 or the needle 2.

In Figure 7 a counter electrode in the shape of a conducting ring 20 is included as part of the ionizing element holder 1 itself.

In Figure 8 an elongated ionizing element holder 21 similar in function to the one shown in Figures 1A and 1B supports a plurality of ionizing elements 2 (needles for instance) all electrically connected together. This arrangement may be used in conjunction with long filters so that ionization can cover the entire area of the filter medium.

In Figure 9A and 9B a thin conductor 22 such as a wire (of the order of .002" dia.) functions as an ionizing element. Conducting posts 24 support wire 22. Conductor 22 may also be made of a bundle of fibres with protruding, sharp fiber ends, such as a string which has been rendered conducting.

Figure 10 shows a similar arrangement to that of Figure 9 but includes a counter-electrode 23 made as part of ionizer holder 21.

In the ionizers described herewith, recess 3 functions to protect ionizing elements 2, 22 from mechanical damage. Therefore, if there is no risk of mechanical damage to the ionizer, recess 3 may be omitted.

Another variant of the invention is shown in Figures 11 and 11A. In these Figures a thin insulating strip of plastic such as polyester or MYLAR(TM) film 37, is applied over and fastened to an outer, upstream-facing

screen 36 of a cartridge filter assembly, deployed in this case in the shape of the letter "H". On top of strip 37 and along its middle line, a fibrous conducting string 38 with ionizing filaments ends (or a thin wire) is attached. A high voltage power supply (not shown in Figures 11-13A) is connected between string 38 and grounded screen 36. String 38 is thereby charged to a voltage of between 5 KV and 18 KV. A high resistance value limiting resistor (not shown) in the high voltage source ensures that no danger of injurious electric shock can arise from contacting the charged string 38.

Operation of this arrangement is as follows: The conducting string 38 ionizes the air in the vicinity of the string by emitting charges 39 via its fine fibre ends. These charges expand into the space in front of the filter and charge the dust particles present in the inflowing air stream. The dust particles are then drawn into the filter by the air flow and are collected by the filter pad 40. The filter's efficiency improves by this arrangement because charged particles of dust are more readily captured by a filter pad 40.

Figures 12 and 12A show another arrangement of Figures 11 and 11A. In this case, insulating strips 37 and string 38 are placed on top of fibrous pad 40. Behind pad 40 is screen 36A which acts as a counter electrode. The insulating strips 37 limit the risk that arcing will occur

between the highly charged screen 36 and the grounded screen 36.

In this arrangement, an electrostatic field may be created between strings 38 and screen 36A which at least partially polarizes fibrous pad 40 as well as forming ions. In this way, the filter's efficiency is increased because of the additional polarization of the filter pad. The polarized media 40 attracts dust particles more readily especially when they are charged by the ions 39 emitted by the ionizer 38.

Yet another similar arrangement is shown in Figures 13 and 13A. Here, insulating strips 37 are placed behind pad 40 and in front of screen/counter-electrode 36A to prevent arcing through the pad 40. This arrangement provides for better polarization of the fibrous pad 40 because the pad is in more direct contact with the ionizing strings.

In Figures 14, 14A the trapping medium 40 of Figure 12 is replaced by a conducting trapping medium 40A. This medium 40A may comprise filaments of conductive plastic or non-conducting filaments with a conductive coating such as carbon. Advantageously, a carbon coating may also have a tendency to absorb odours.

The use of conductive trapping media 40A is believed to reduce the tendency for charge to accumulate within the trapping medium 40A which may otherwise reduce the rate at which ions are being emitted.

Figures 15, 15A depict an externally mounted string-type ion-emitter 38 surmounting a "sandwich" of polarizable trapping medium 40 contained between two screens 36, 36A. In this case charged dust particles 39 are expected to pass through openings in the upper screen 36 due to their containment in the air stream. Once they have passed this screen 36 such particles are trapped by the medium 40. By providing different voltages for the upper and lower screens 36, 36A, such medium 40 may optionally be polarized.

By providing an ionizer which is thin and mounted on the face of a filter unit 10, the combined unit may be easily installed through a slot 31 in an air duct 30 as shown in Figure 16. When the filter 10 carries an attached high voltage supply 11, a combined unit is created which is low cost, easy to install and maintain, and is highly efficient at cleaning air or other gas flows.

As an alternative to attaching the ion emitter to a filter 10, as shown in Figure 16, the ionizing element holder 1 may be carried by an arm 33 of insulative material and thin cross-section as to position the ion source 2 adjacent the filter 10 on its upstream side as shown in Figure 16A. While it is convenient for a filter to carry the ion source 2, it is sufficient for the ion source 2 to be held separately adjacent the filter.

Tests have been effected comparing a filter without the ionizer and the same filter with the ionizer.

The results of these tests are shown in the graph of Figure 17.

In Figure 17 the upper curve represents performance results for a polarized filter without external ionization. Results are presented in terms of removal of smoke particles over time, in a closed room, measured for 0.3 micron particle size. The lower curve provides results for the same filter after addition of four ionizing needles positioned on its external, upstream surface. The rate of decrease of particle counts is clearly higher with external ionization present. The results represent a major improvement in air filtration efficiency.

CONCLUSION

The foregoing has constituted a description of specific embodiments showing how the invention may be applied and put into use. These embodiments are only exemplary. The invention in its broadest, and more specific aspects, is further described and defined in the claims which now follow.

These claims, and the language used therein, are to be understood in terms of the variants of the invention which have been described. They are not to be restricted to such variants, but are to be read as covering the full scope of the invention as is implicit within the invention and the disclosure that has been provided herein.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY ARE CLAIMED AS FOLLOWS:

1. An air filtration assembly comprising:

(a) a trapping medium for removing particles from an air stream to be filtered;

(b) an ion source positioned adjacent to the outerface surface of the trapping medium to emit ions outwardly from said medium into an oncoming air stream whereby a zone of ionized air may be formed within the air stream in advance of the trapping medium and the ion source.

2. An air filtration assembly as in claim 1 wherein the ion source is carried and supported by the trapping medium.

3. An air filtration assembly as in claim 1 wherein the trapping medium is a fibrous, polarizable substance which may be polarized by an applied electrical potential field.

4. An air filtration assembly as in claim 1 wherein the ion source is thin enough to allow for the insertion of the ion source and trapping medium into a slot in an air cleaning apparatus.

5. An air filtration assembly as in claim 1 wherein the ion source comprises a sharp-ended, ion-forming portion which is sufficiently sharp that, upon being provided with an ionizing voltage creates a local field gradient around said sharp-ended portion of sufficient intensity to create

ions in the air, but without creating an undue amount of ozone.

6. An air filtration assembly as in claim 5 wherein the ion source is supported by a thin, insulated holder which is attached to said outer face surface of the trapping medium.

7. An air filtration assembly as in claim 1, 2, 3, 4, 5 or 6 wherein the ion source comprises a needle or sharply pointed conducting fibres.

8. An air filtration assembly as in claim 1 in combination with a high voltage power supply connected to said ion source to cause said ion source to emit ions.

9. An air filtration assembly as in claim 1 comprising:

1) an insulated holder;
2) a sharply pointed <u>electrode</u> which serves as the ion source; and
3) a resilient support for the <u>electrode</u>, connected to the holder

whereby the needle is resiliently mounted in an upright position to permit the electrode to be bent over and enable a filter on which the holder is attached to pass through a slot in an air handling system.

10. An air filtration assembly as in claim 9 wherein:

1) the insulated holder has an outer surface;
2) the sharply pointed electrode 15 is a needle; and

3) a recess is formed in the outer surface of the holder

wherein the needle is positioned within the recess without protruding above said outer surface.

11. An air filtration assembly as in claim 1 comprising a field-gradient-inducing counter electrode.

12. A filter assembly as in claim 1 comprising:

1) an insulated holder for the ion source;

2) an ion emitting portion on said ion source; and

3) a counter-electrode, positioned at a spaced distance from said ion emitting portion to provide, where charged, a potential gradient around the ion emitting porion that is high enough to produce ionization but not so high as to produce corona or arcing.

13. An air filtration assembly comprising:

(1) an air trapping medium having an exposed, outer, air receiving, upstream surface;

(2) an ionizing element supported by an insulated holder and carried on the air receiving surface of trapping medium;

(3) first electrical coupling means extending from said ionizing element for coupling to a first output of a voltage potential source; and

(4) a counter-electrode, with second electrical coupling means for coupling the counter-electrode

to a second output of said voltage potential source

wherein the spacing between said ionizing element and said counter-electrode element is sufficient, upon provision of a voltage potential between said first and second outputs, to cause the formation of ions in air surrounding the ionizing element.

14. An assembly as in claim 13 wherein said trapping medium comprises a fibrous filter pad.

15. An assembly as in claim 14 that is thin enough to allow for the insertion of the filtration assembly into a slot.

16. An assembly as in claim 14 in combination with a voltage potential source to form a field gradient that will create ions in the air, but without creating an undue amount of ozone.

17. An assembly as in claim 16 wherein the voltage potential source is part of a power supply of an electronic air filter.

18. An assembly as in claim 13 wherein the ionizing element is a needle.

19. An assembly as in claim 13 wherein the ionizing element comprises thin fibres of conducting material.

20. An assembly as in claim 13 wherein the holder is dome-shaped with a recess formed in its outer face, and the ionizing element is a needle that is positioned within the recess.

21. An assembly as in claim 20 in combination with a counter-electrode positioned around the periphery of the holder.

22. A filter as in claim 14 in combination with a conducting screen positioned adjacent said pad on a side of said pad opposite said ionizing source and a high voltage source, electrically connected between said screen and said ionizing source to provide said ionizing voltage.

23. A filter as in claim 22 characterized by said ionizing source comprising an electrical conductor having multiple, exposed ionizing points distributed along its length.

24. A filter as in claim 22 characterized by being in combination with a voltage power supply which provides a potential between the ionizing source and the conducting screen of between 5,000 and 15,000 volts.

25. An air filtration assembly as in claims 1 or 13 wherein the trapping medium is electrically conductive.

26. An air filtration assembly as in claim 25 wherein the trapping medium comprises fibers coated with carbon.

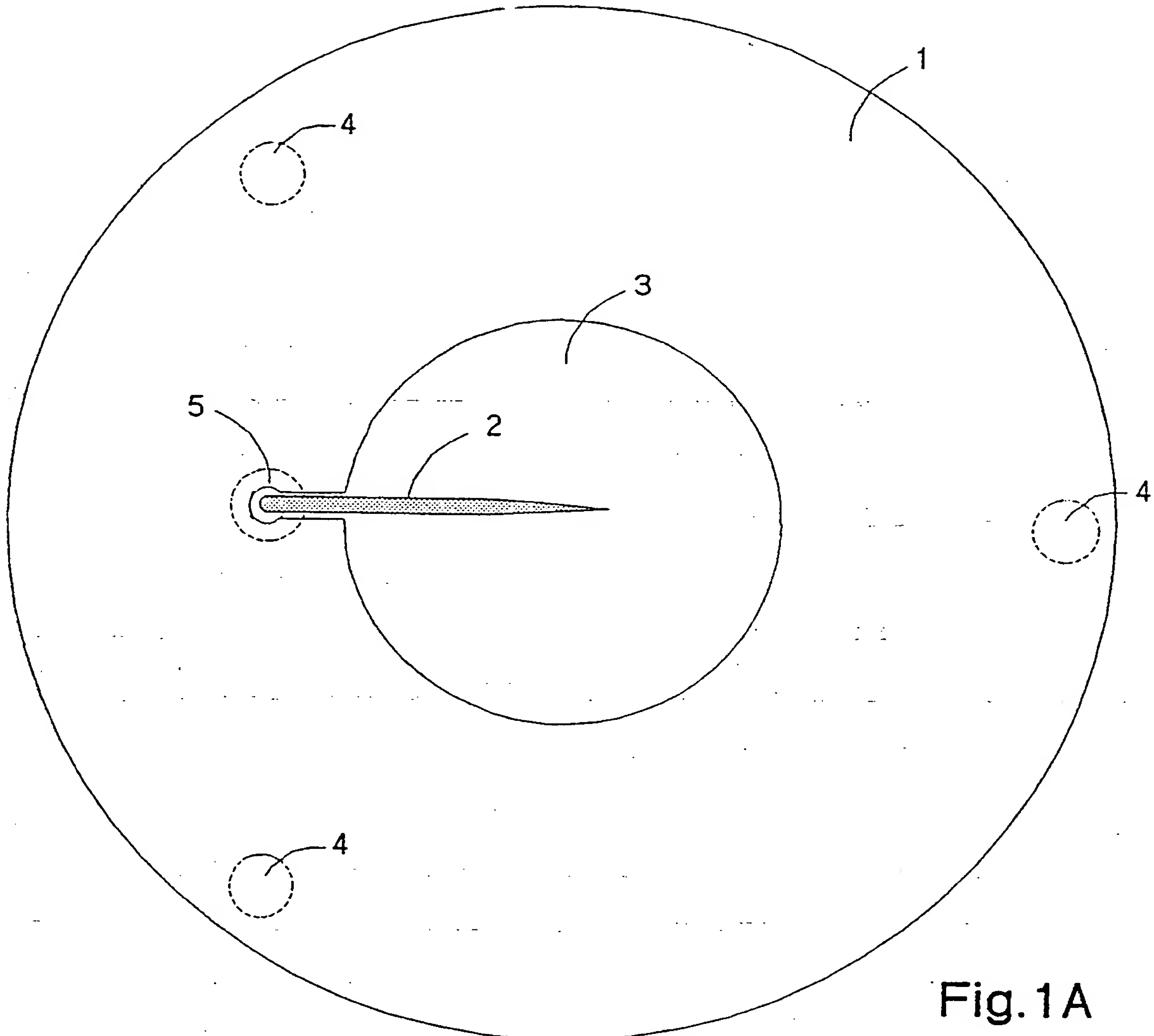

Fig.1A

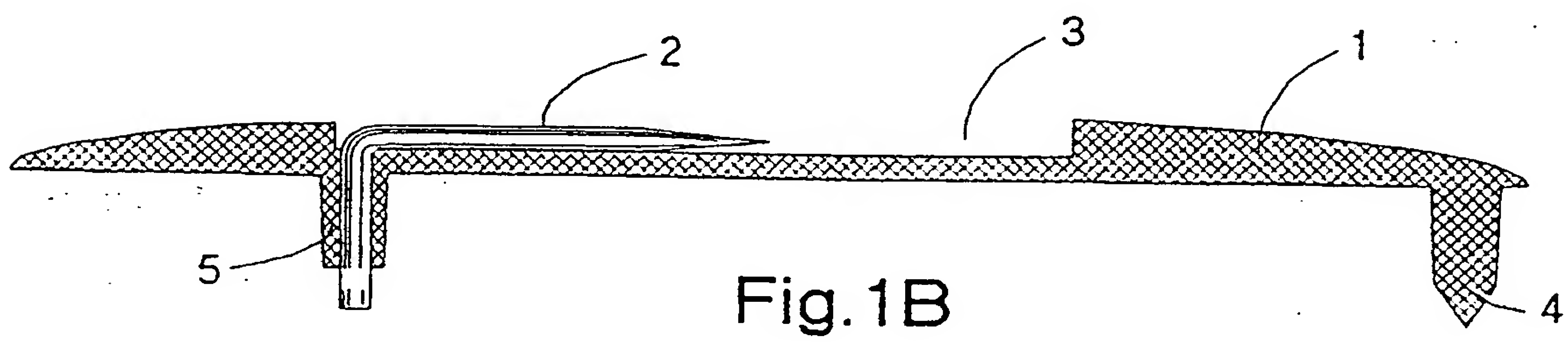

Fig.1B

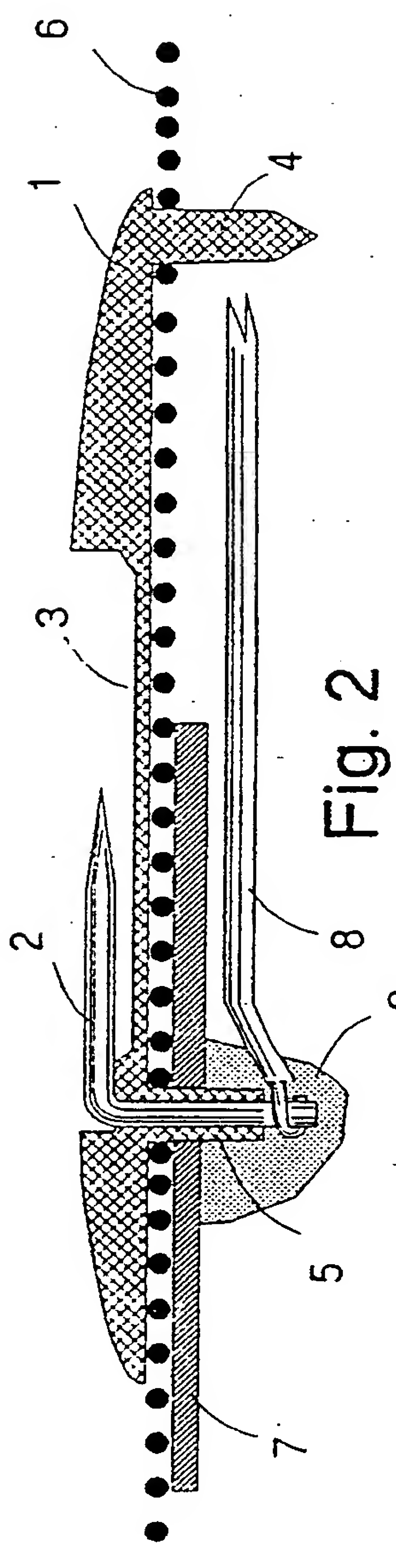

Fig. 2

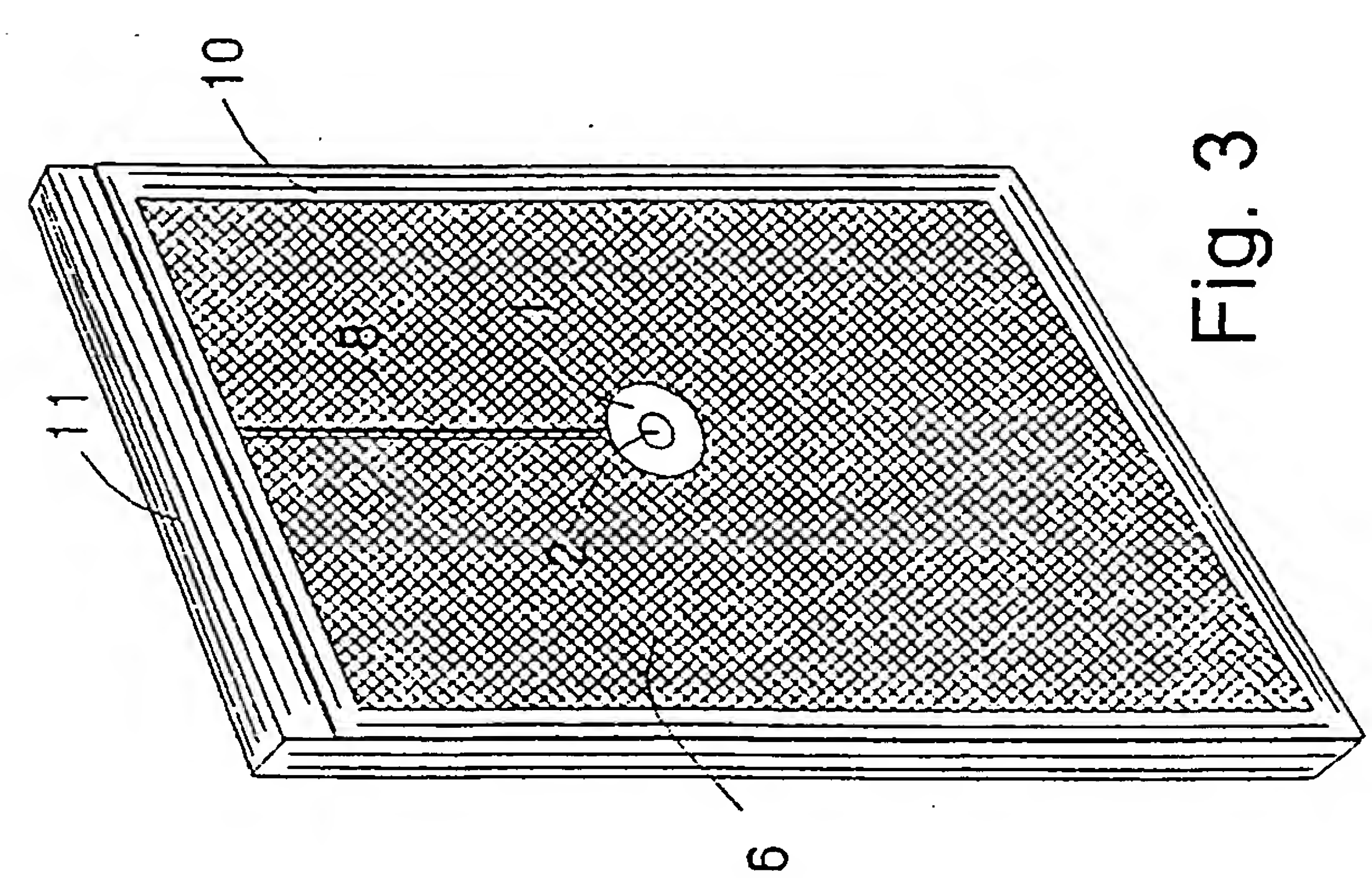

Fig. 3

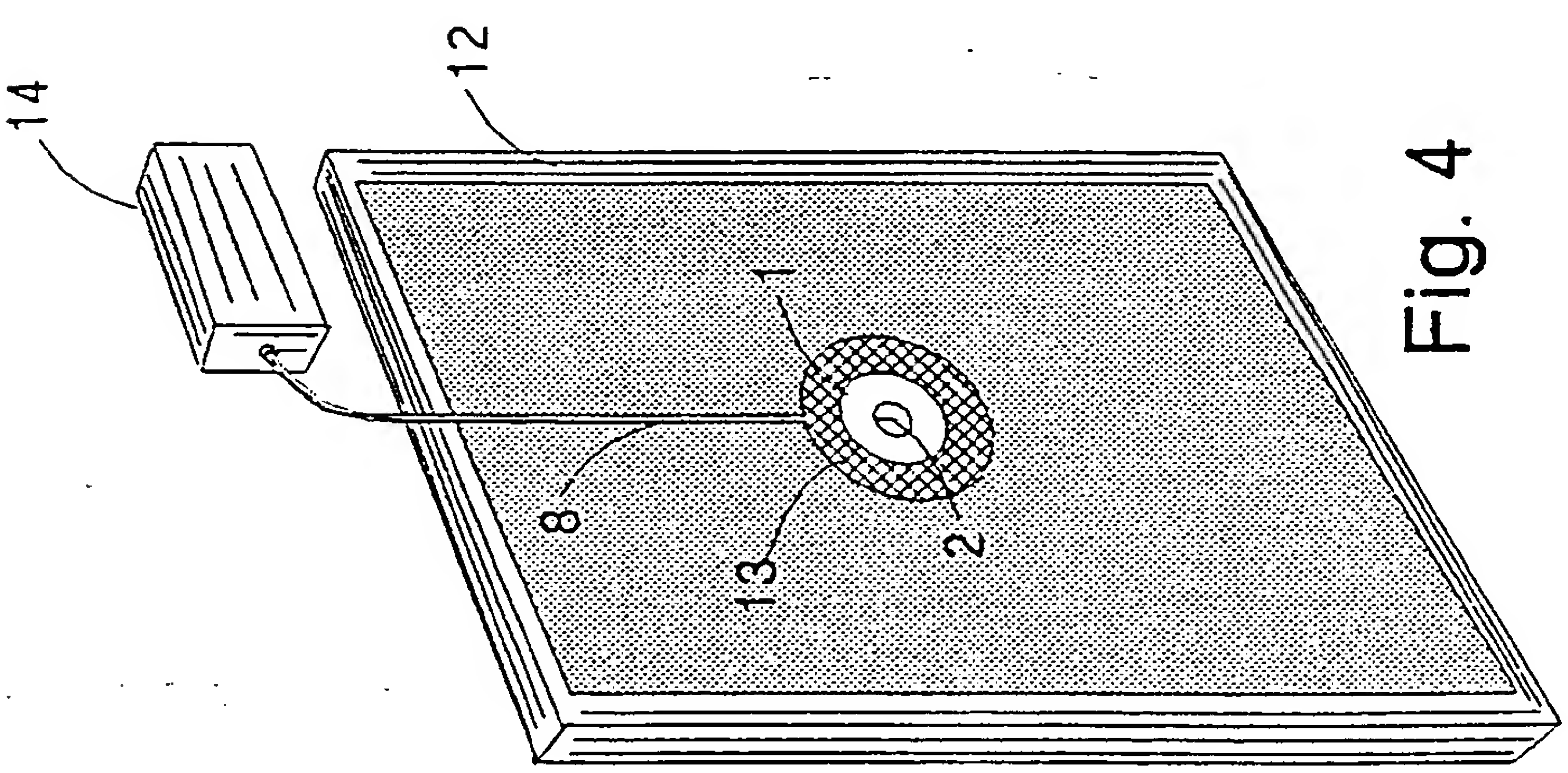

Fig. 4

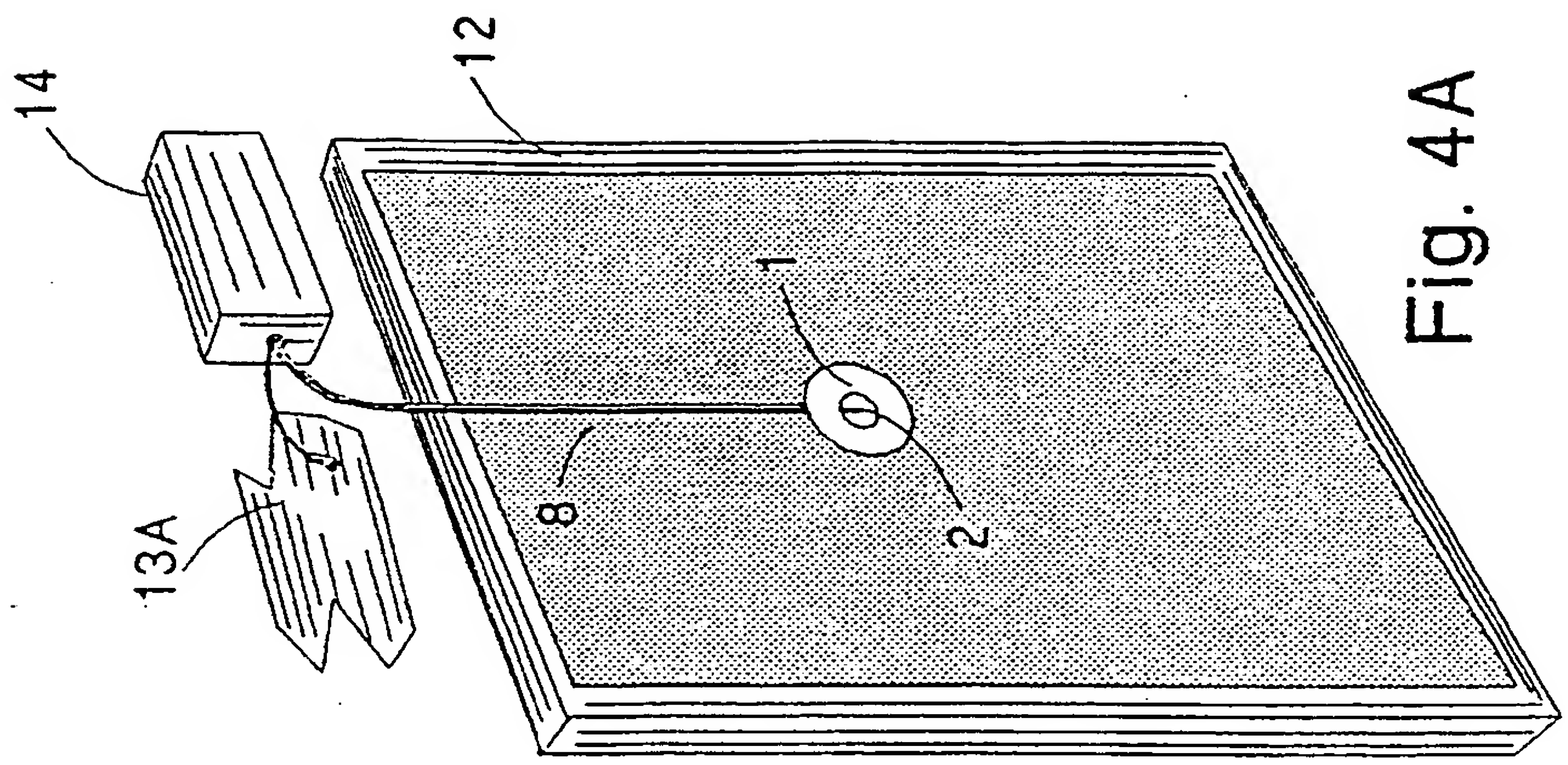

Fig. 4A

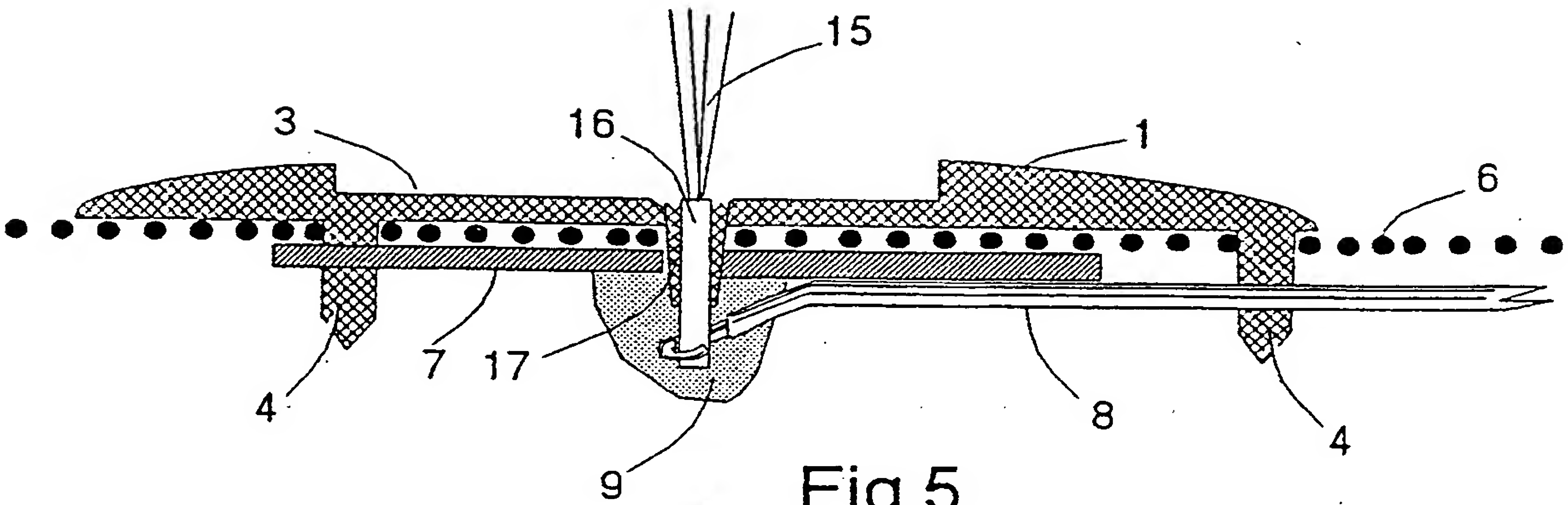

Fig.5

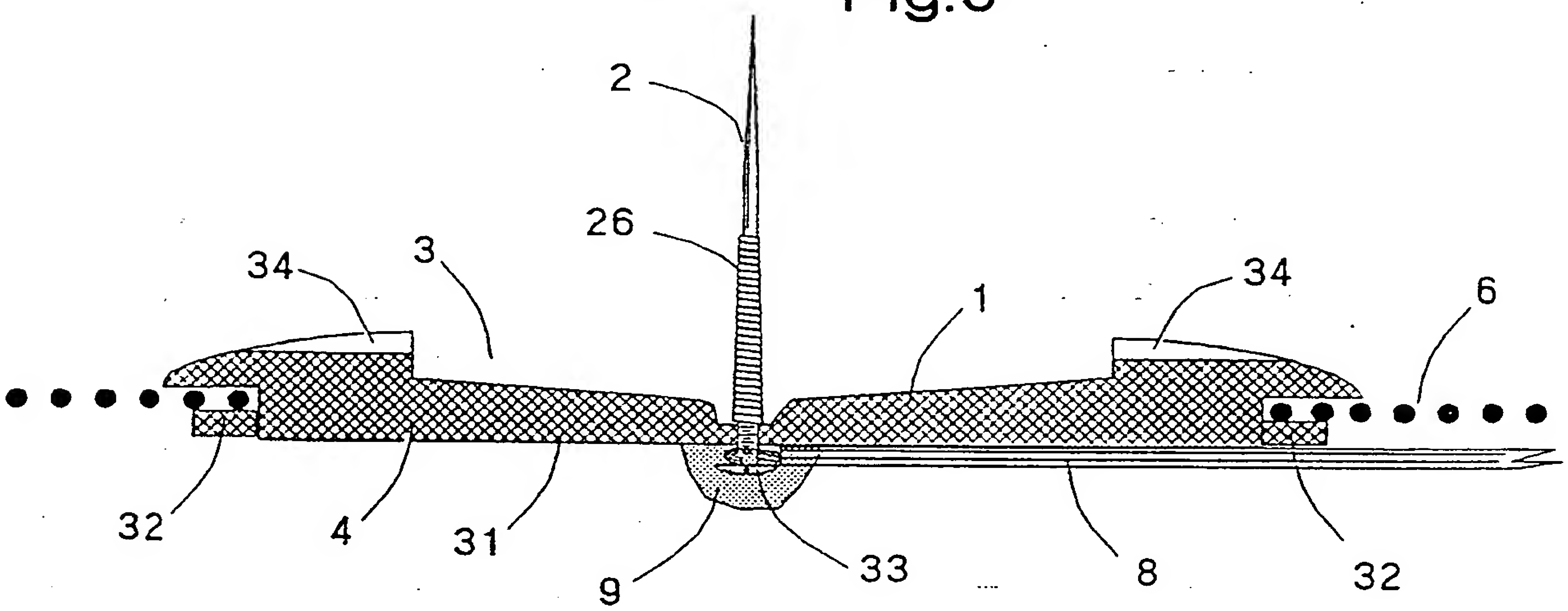

Fig.6

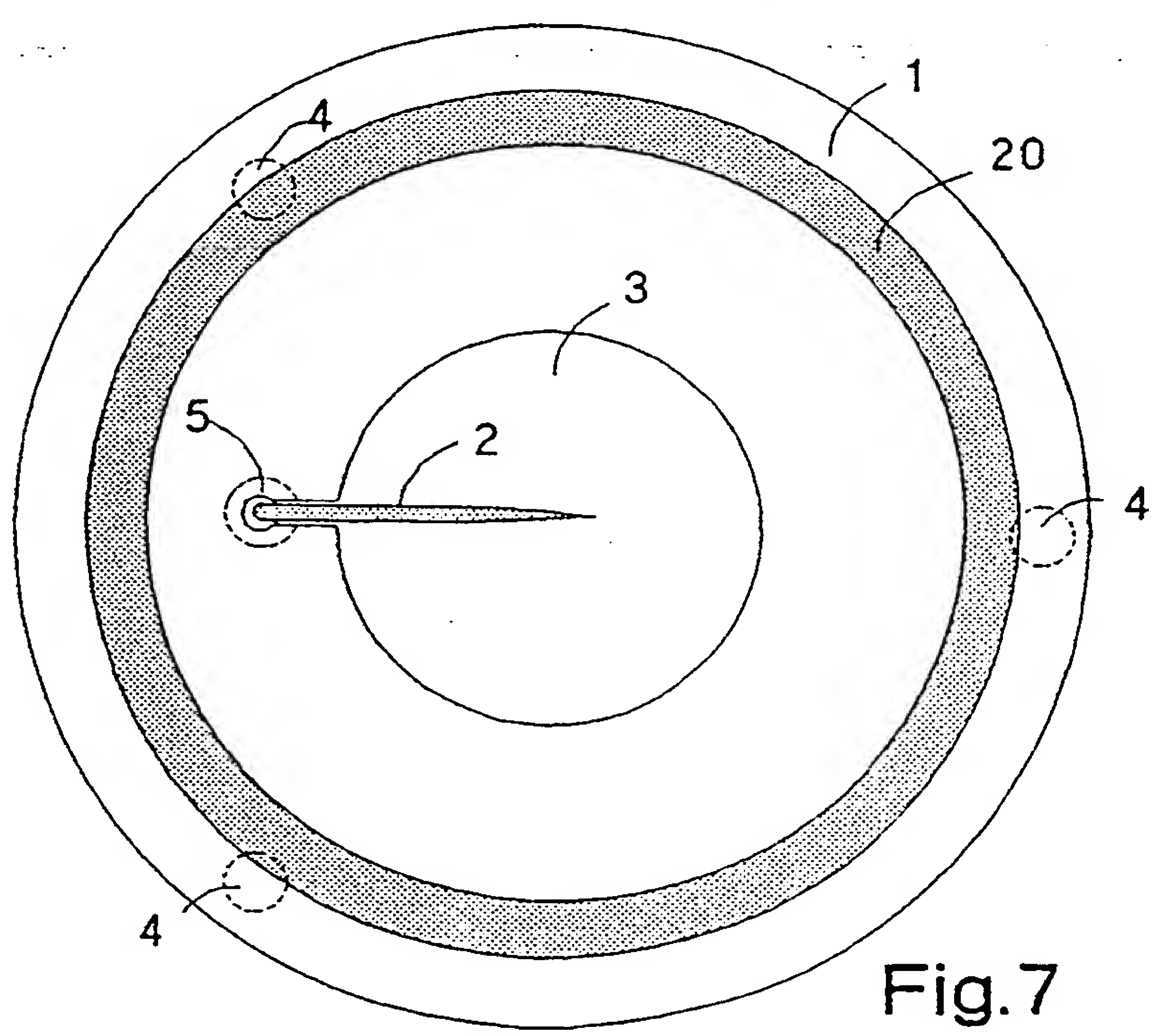

Fig.7

SUBSTITUTE SHEET (RULE 26)

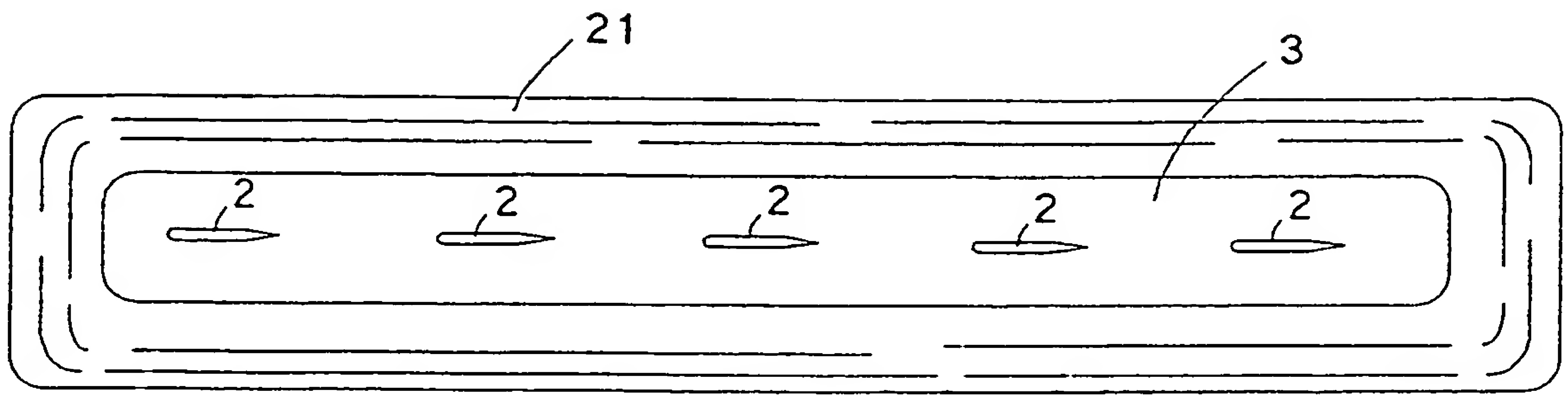

Fig.8

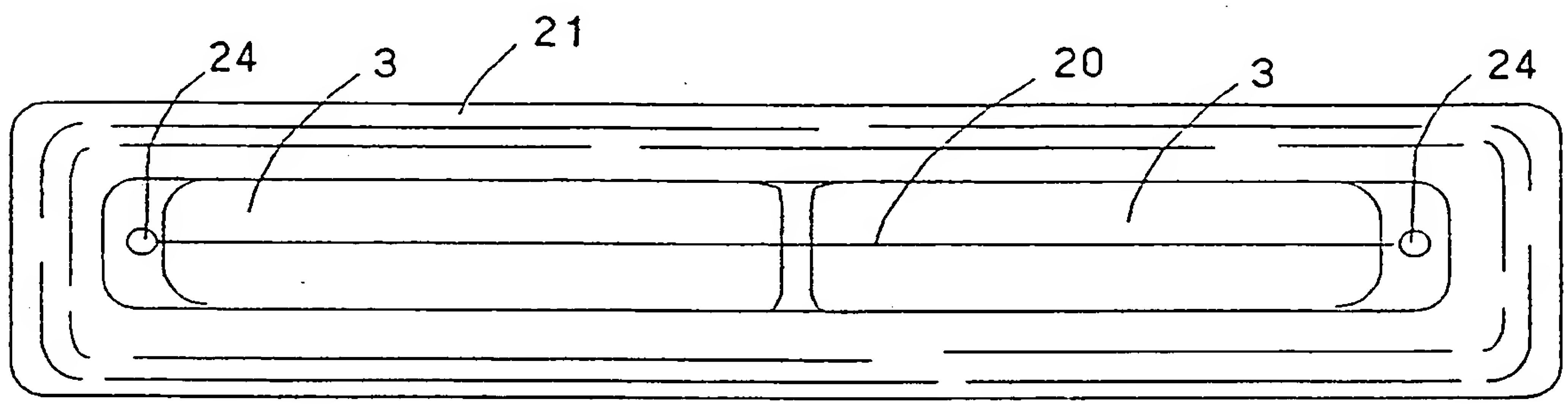

Fig.9A

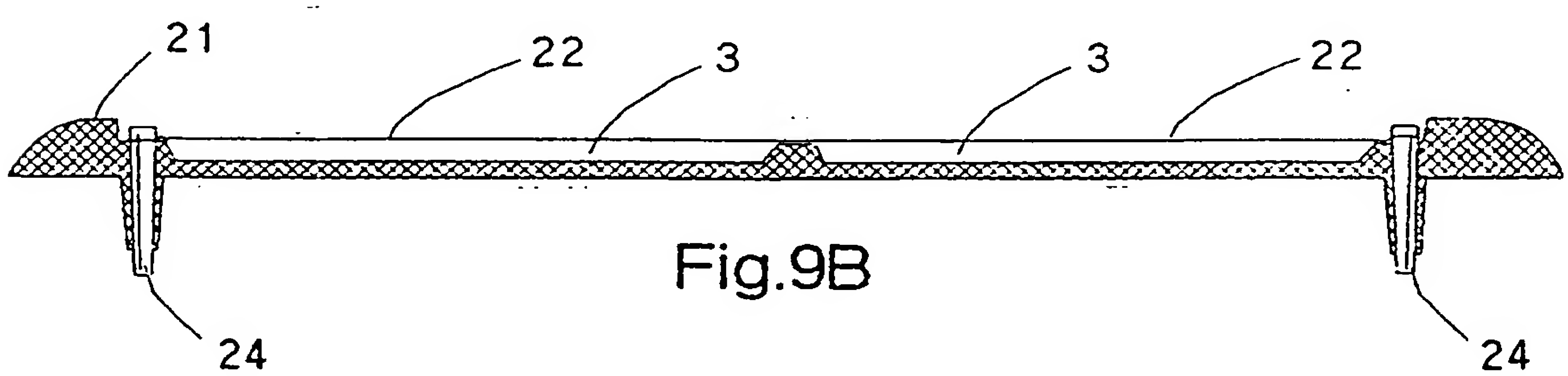

Fig.9B

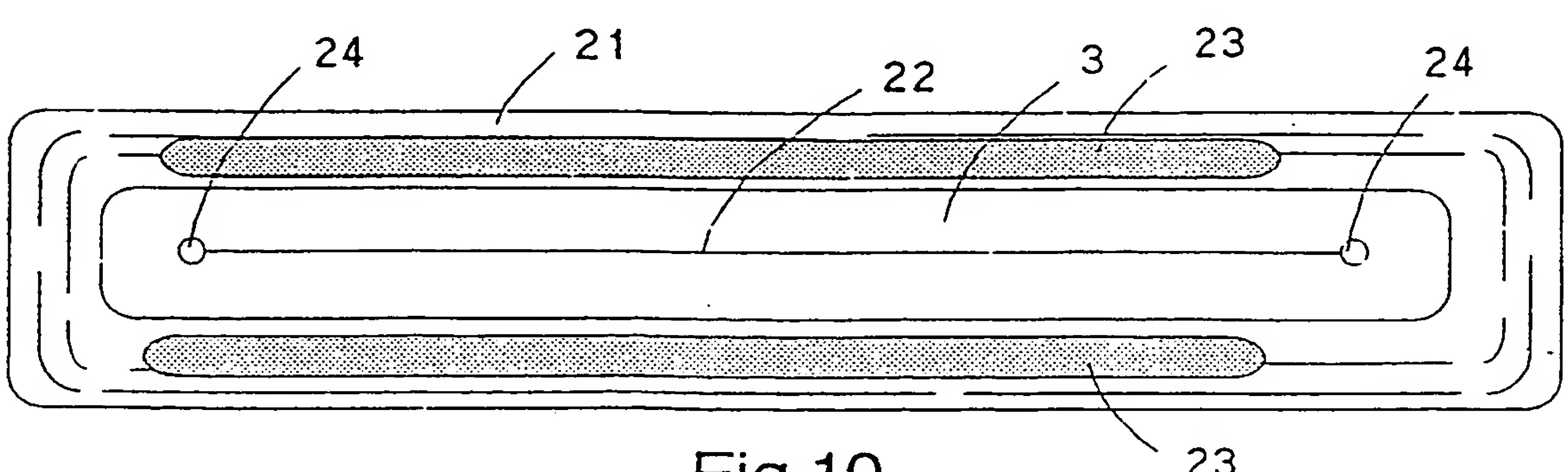

Fig.10

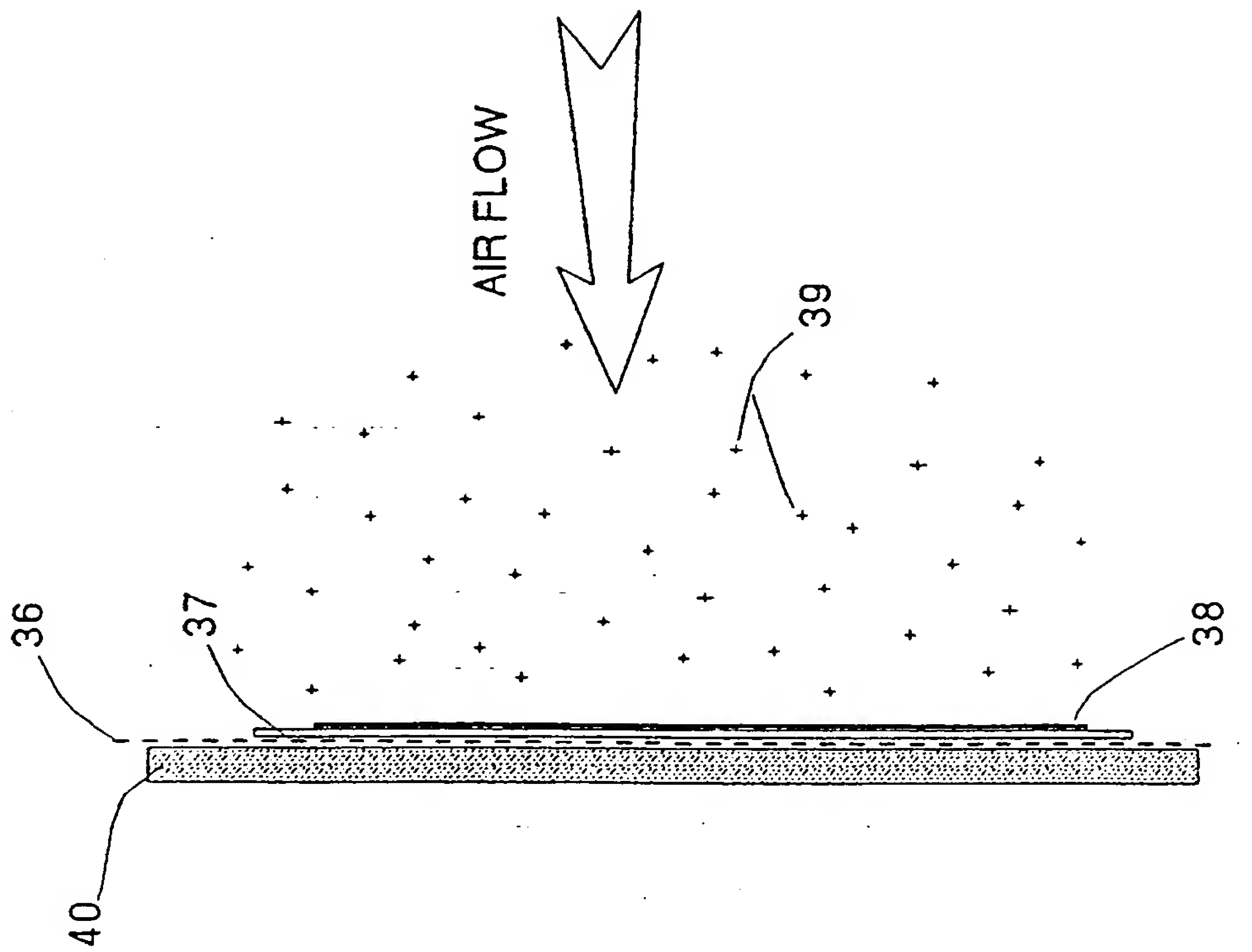

FIG. 11A

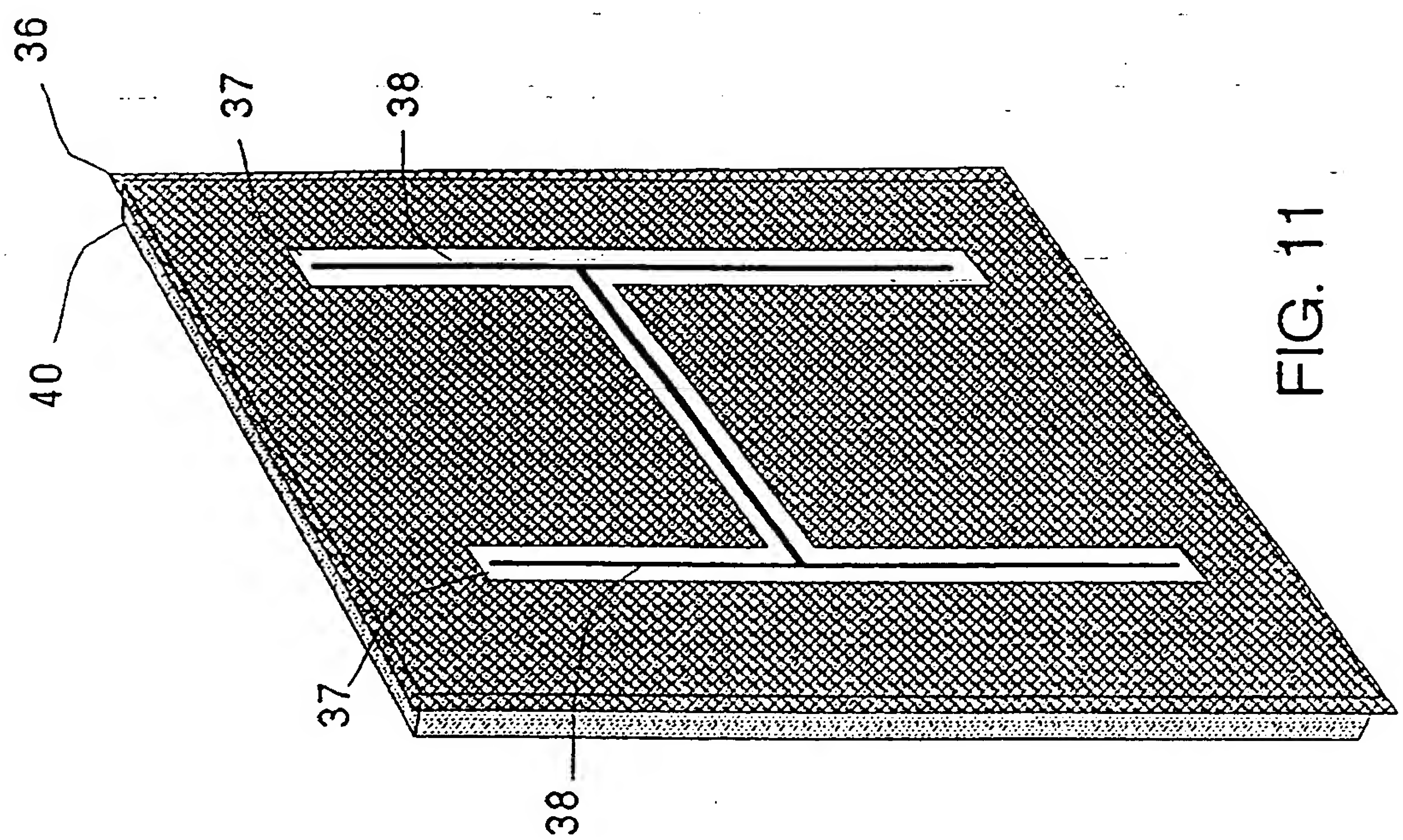

FIG. 11

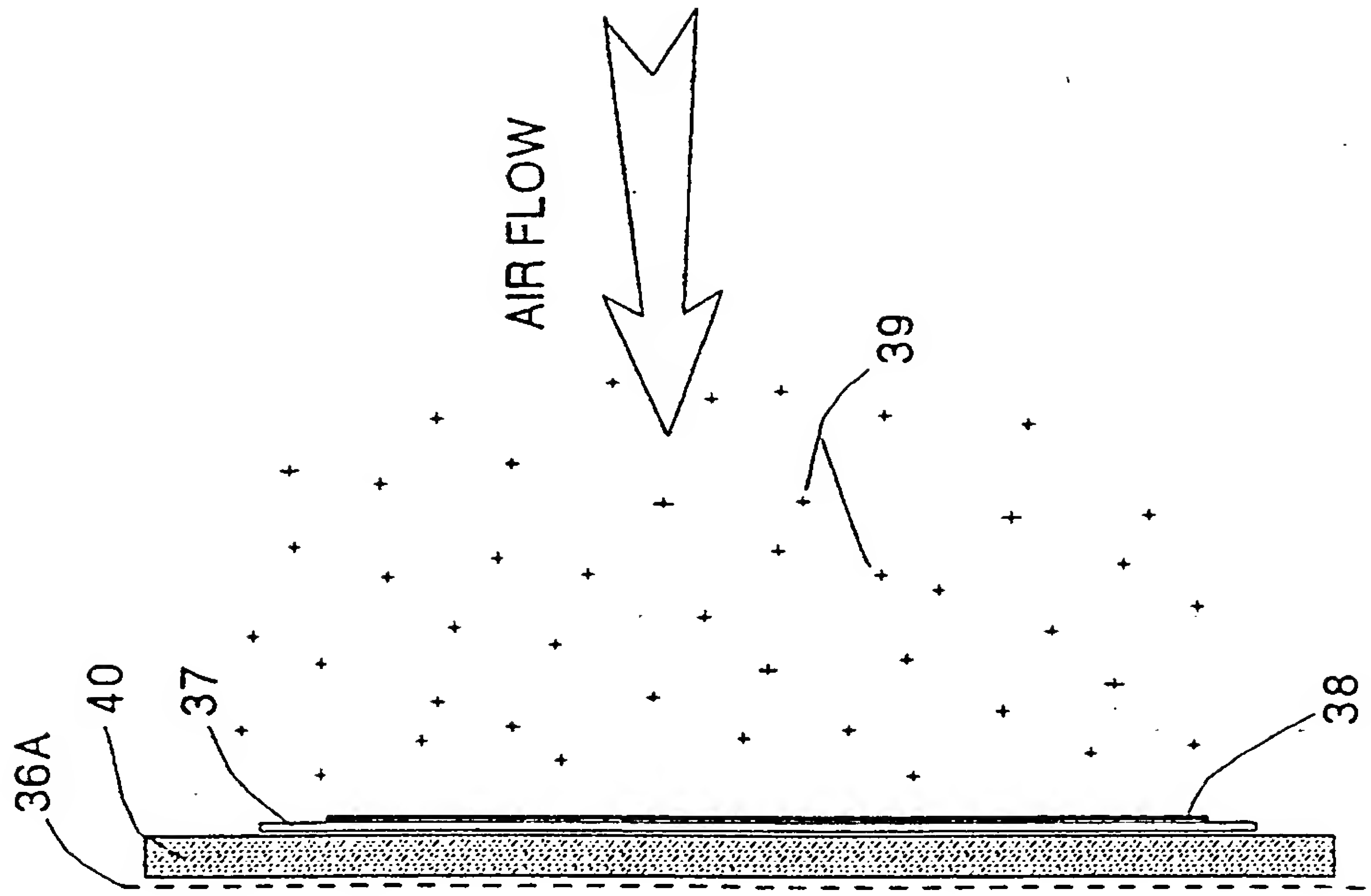

FIG. 12A

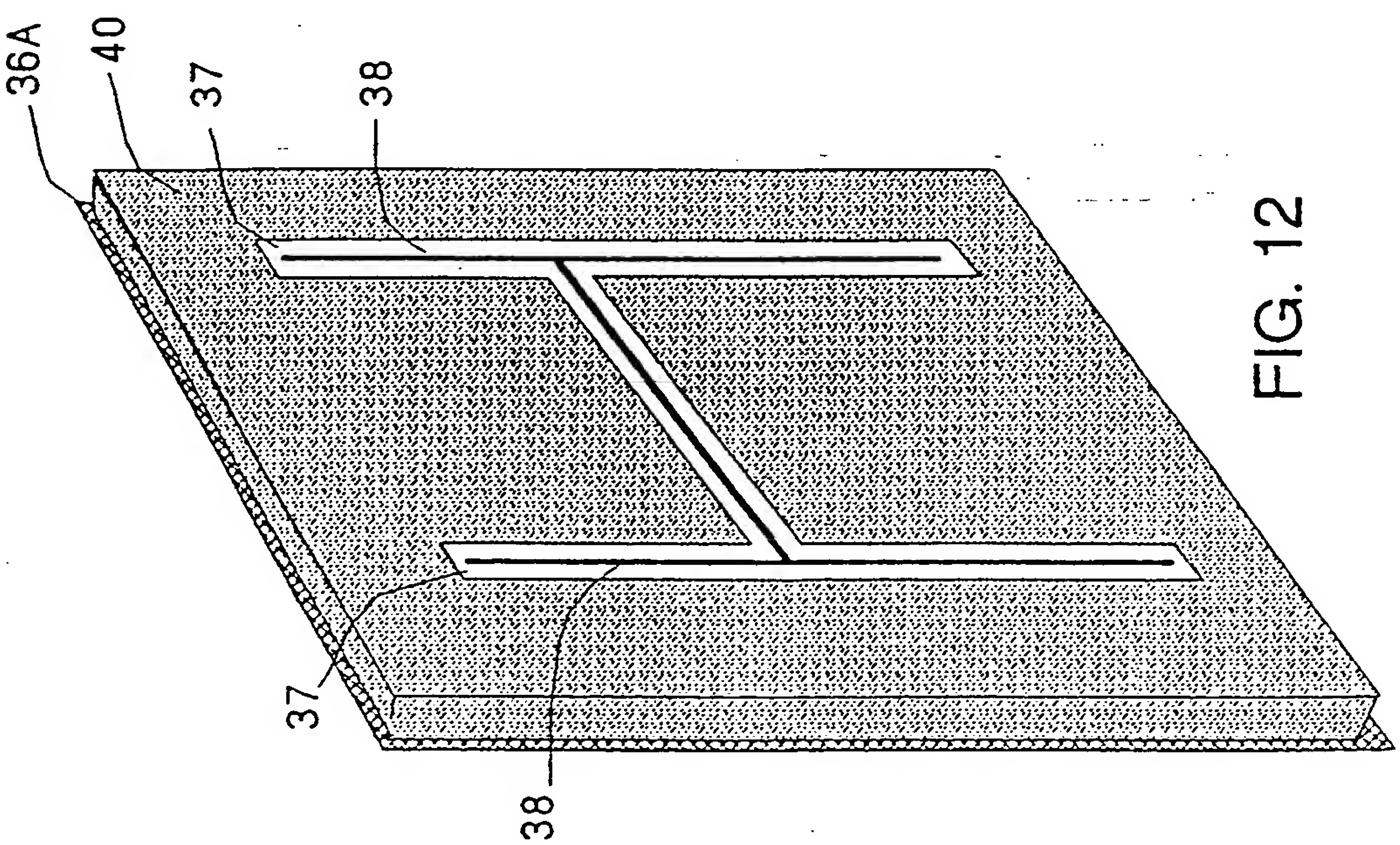

FIG. 12

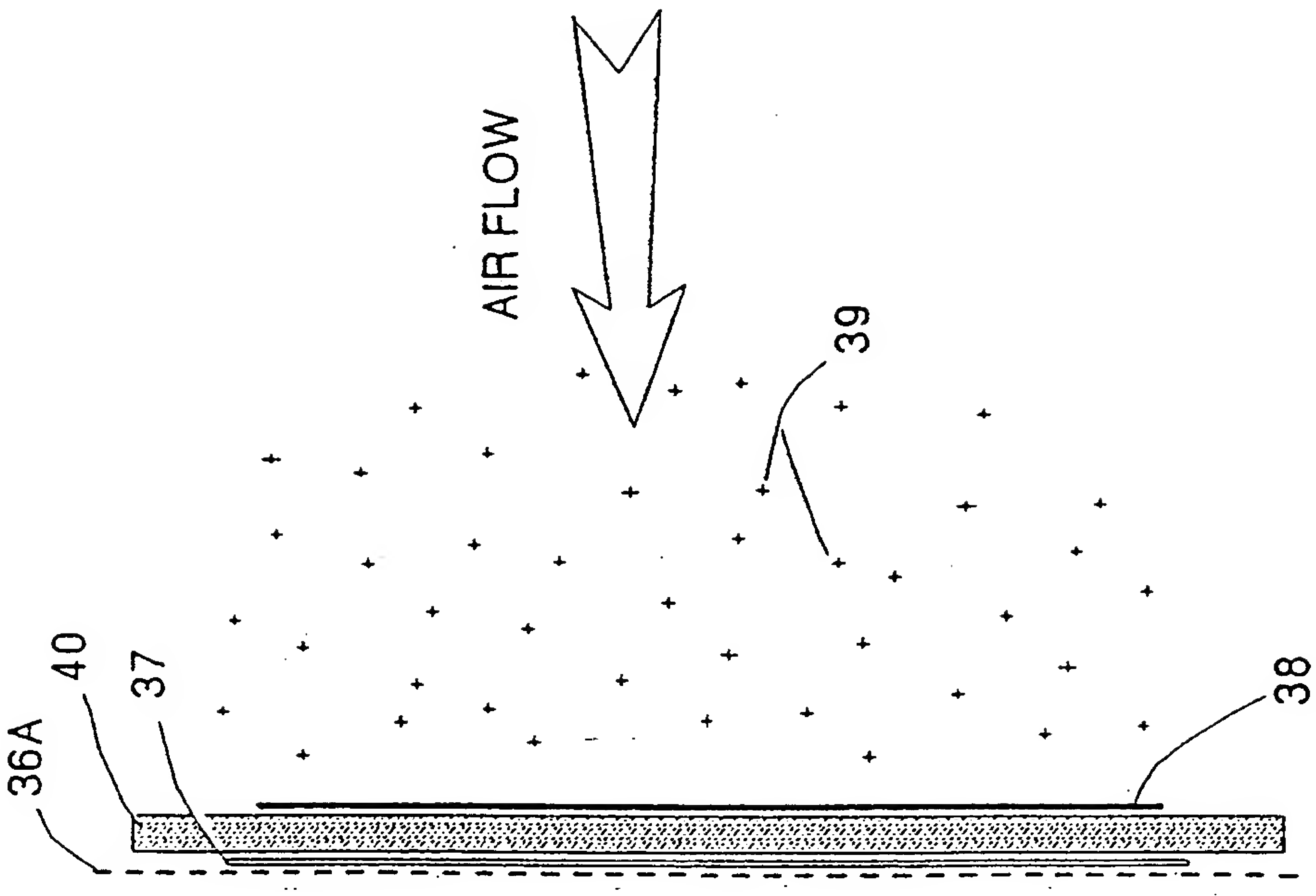

FIG. 13A

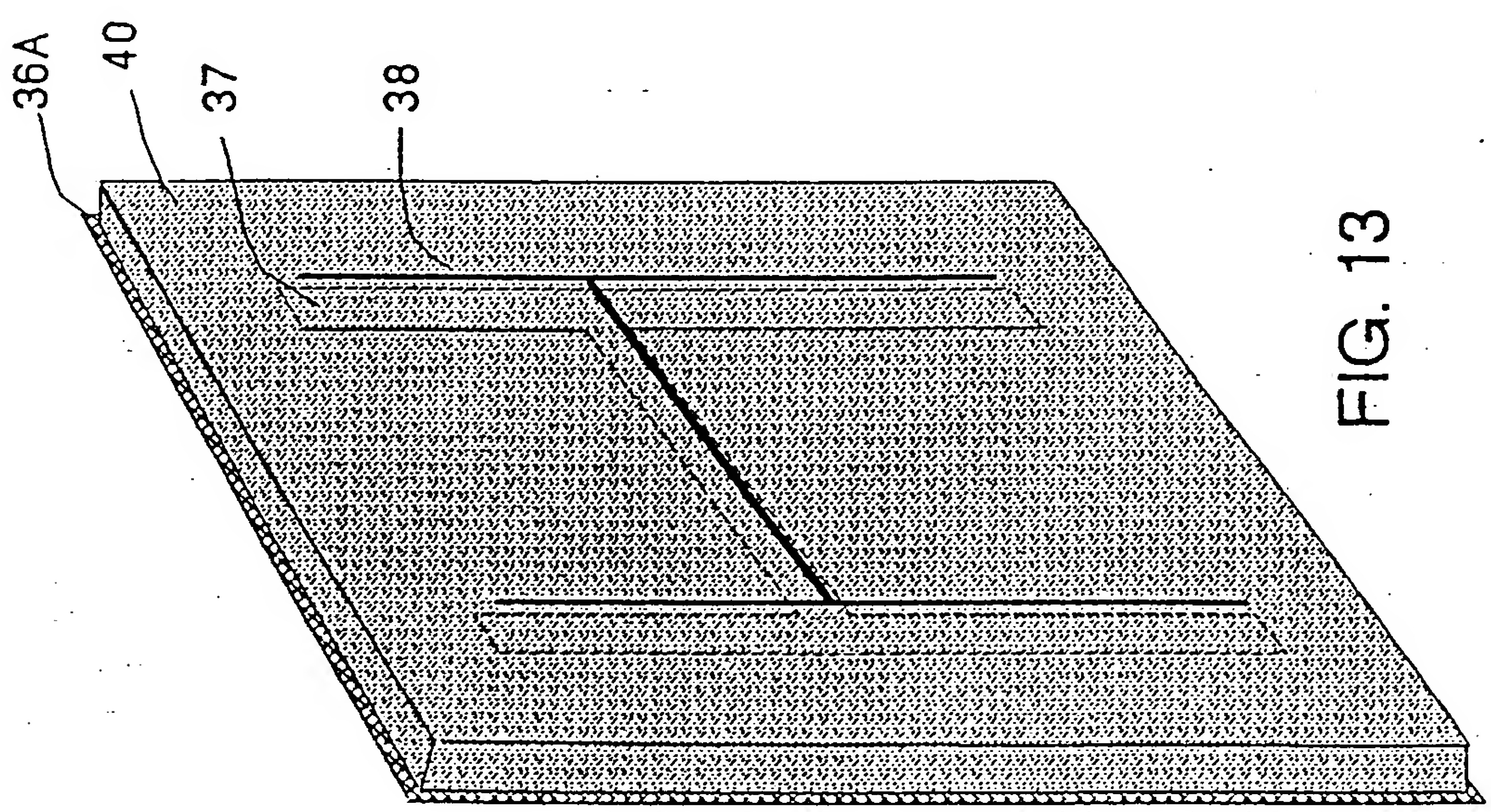

FIG. 13

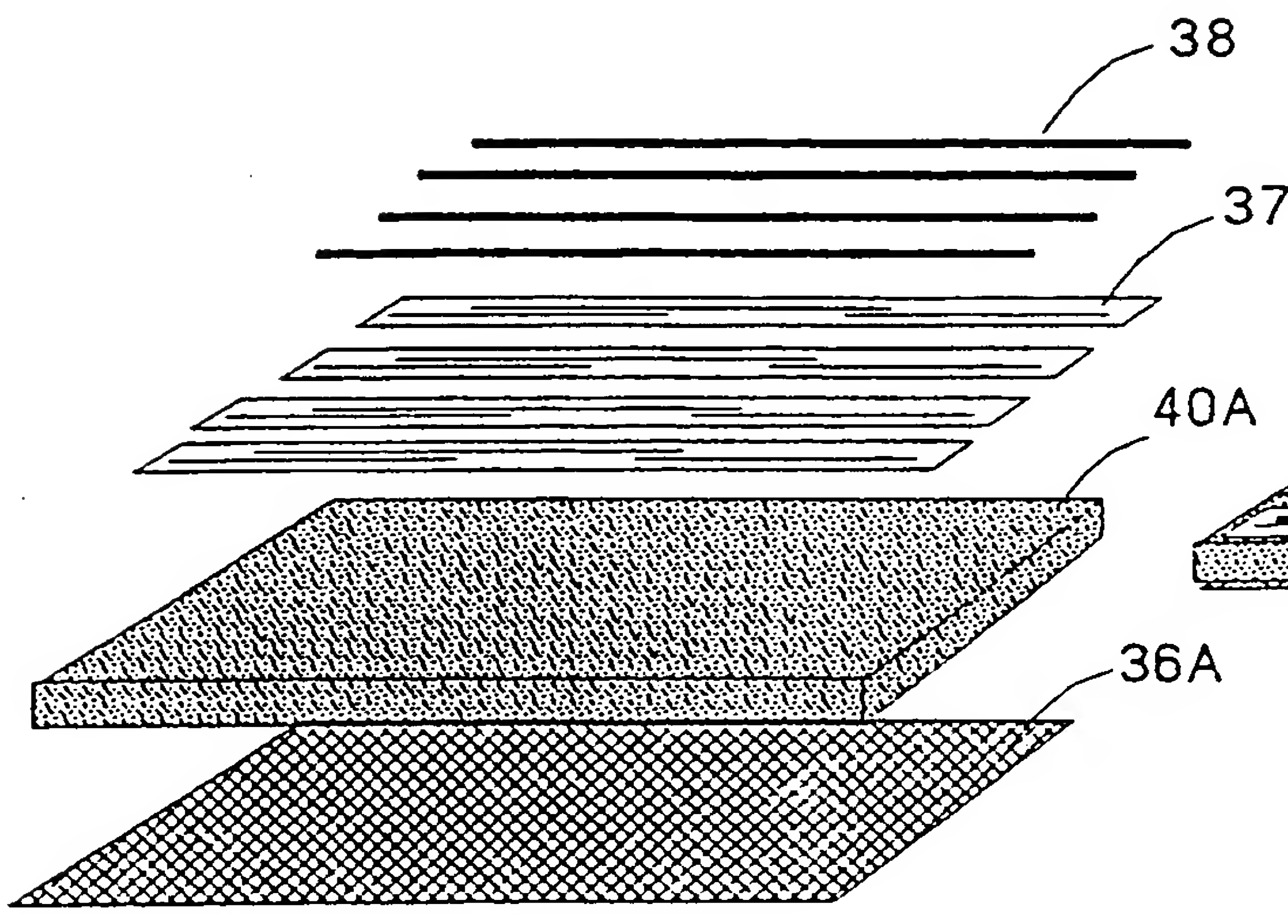

Fig. 14

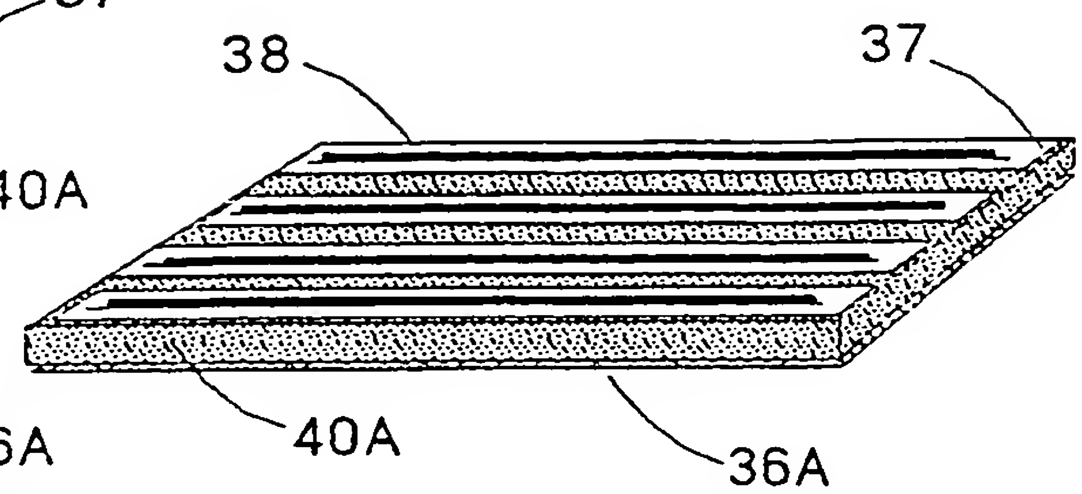

Fig. 14A

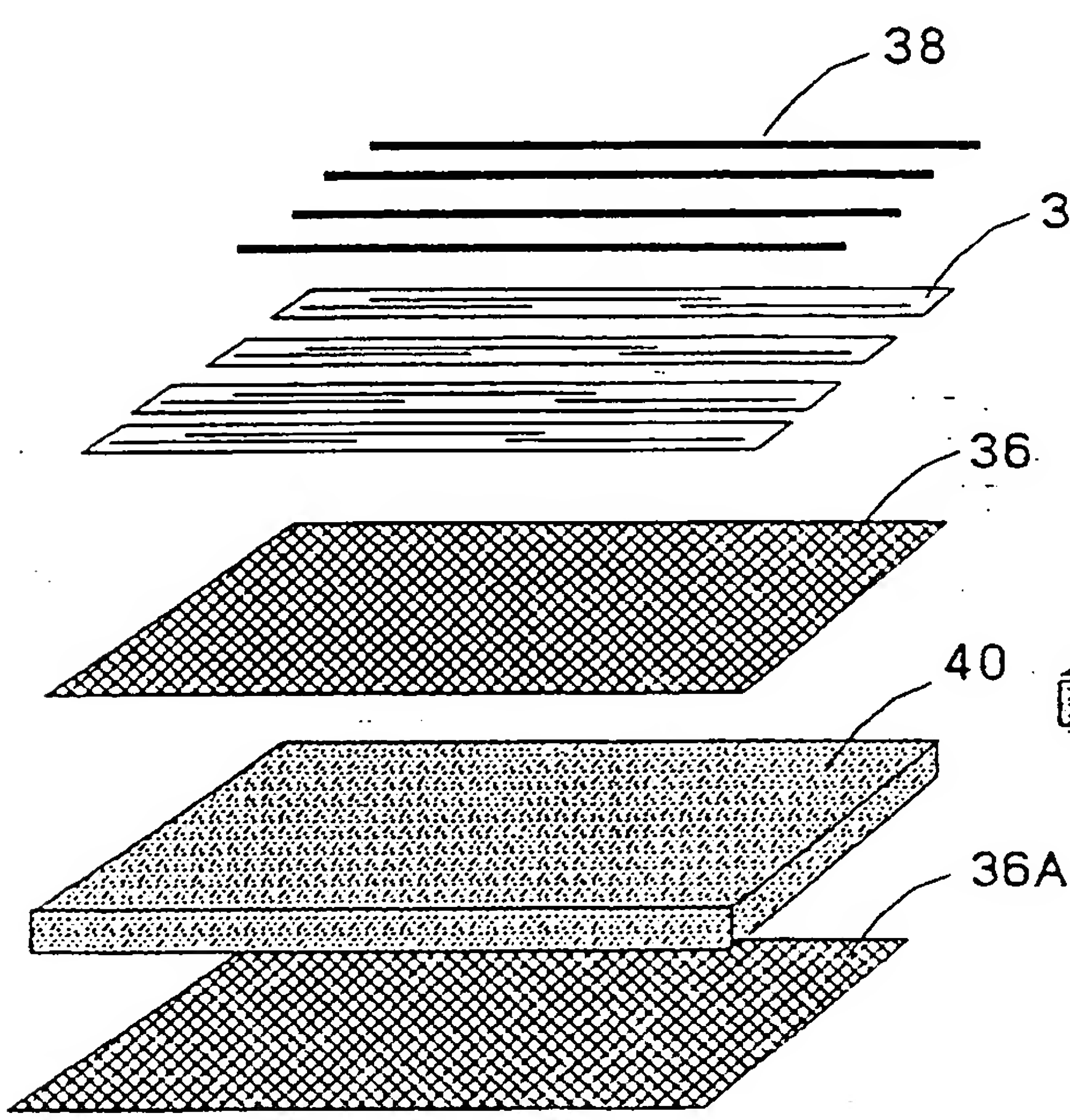

Fig 15

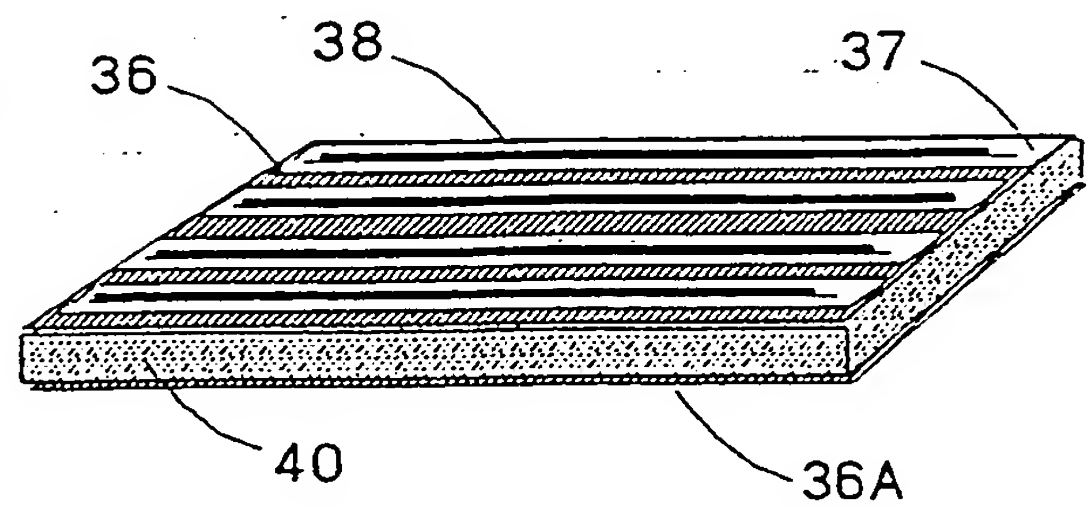

Fig.15A

SUBSTITUTE SHEET (RULE 26)

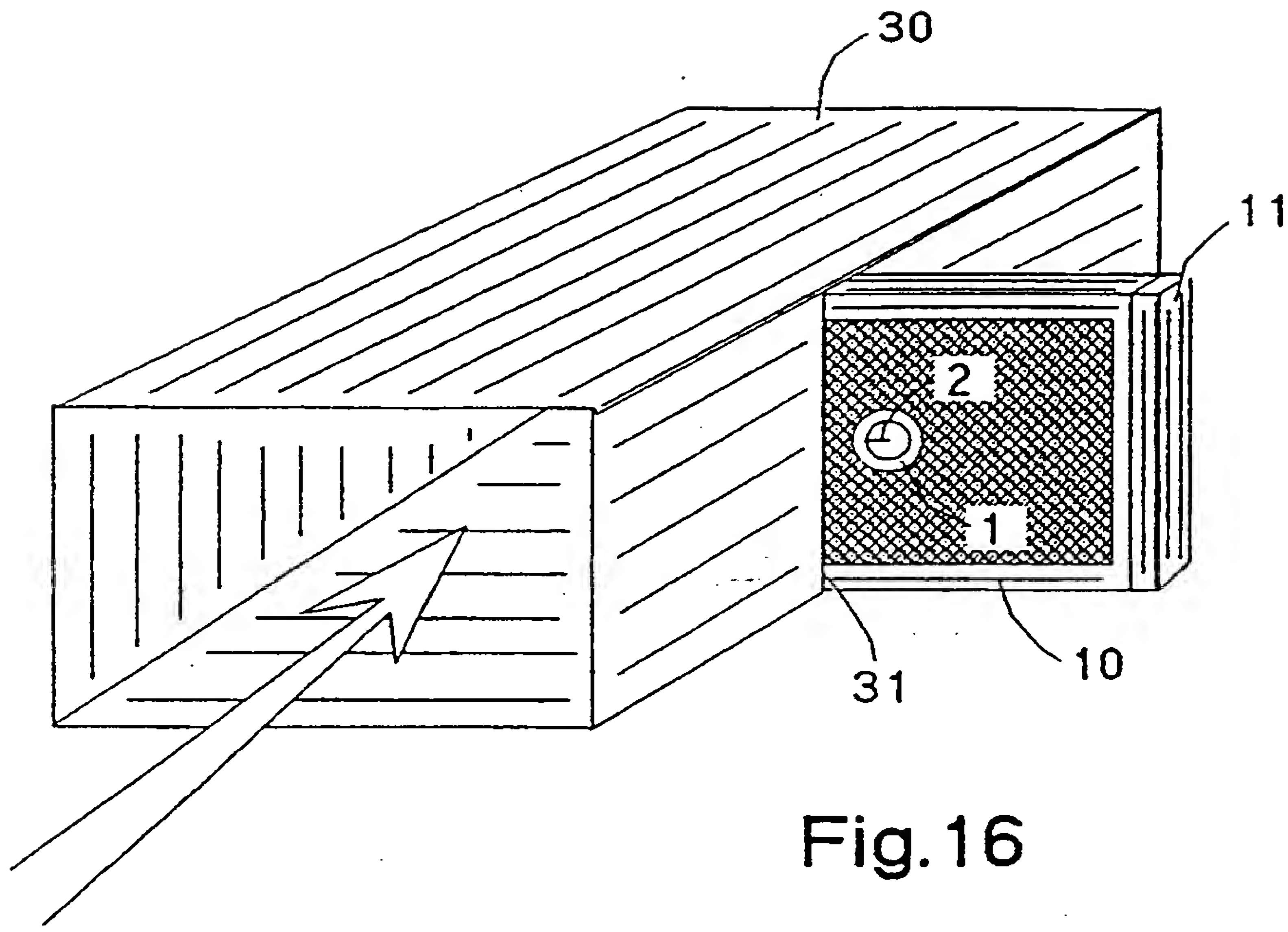

Fig.16

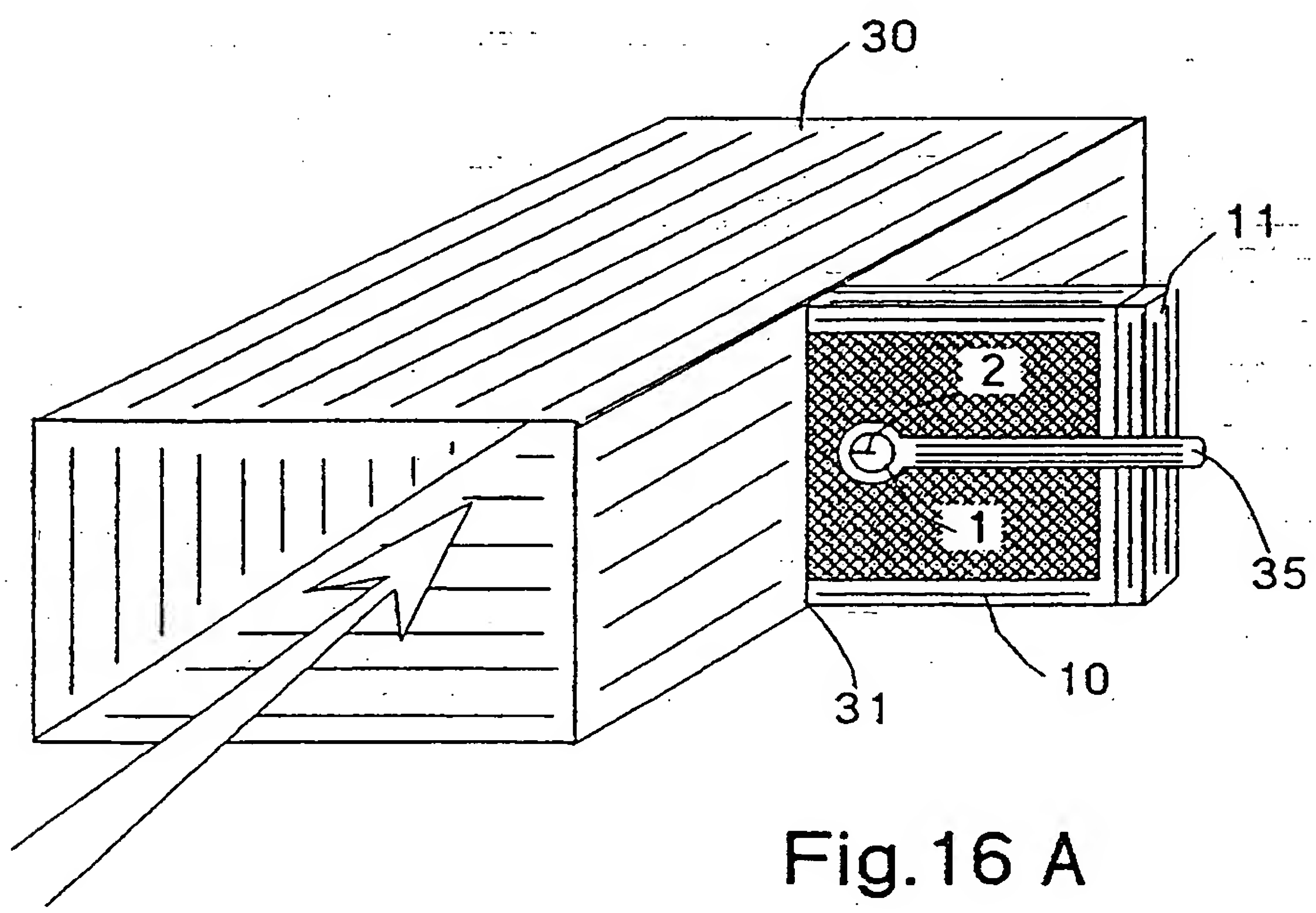

Fig.16 A

COMPARATIVE TEST ON FILTER WITH 4 NEEDLES PRODUCING EXTERNAL IONIZATION

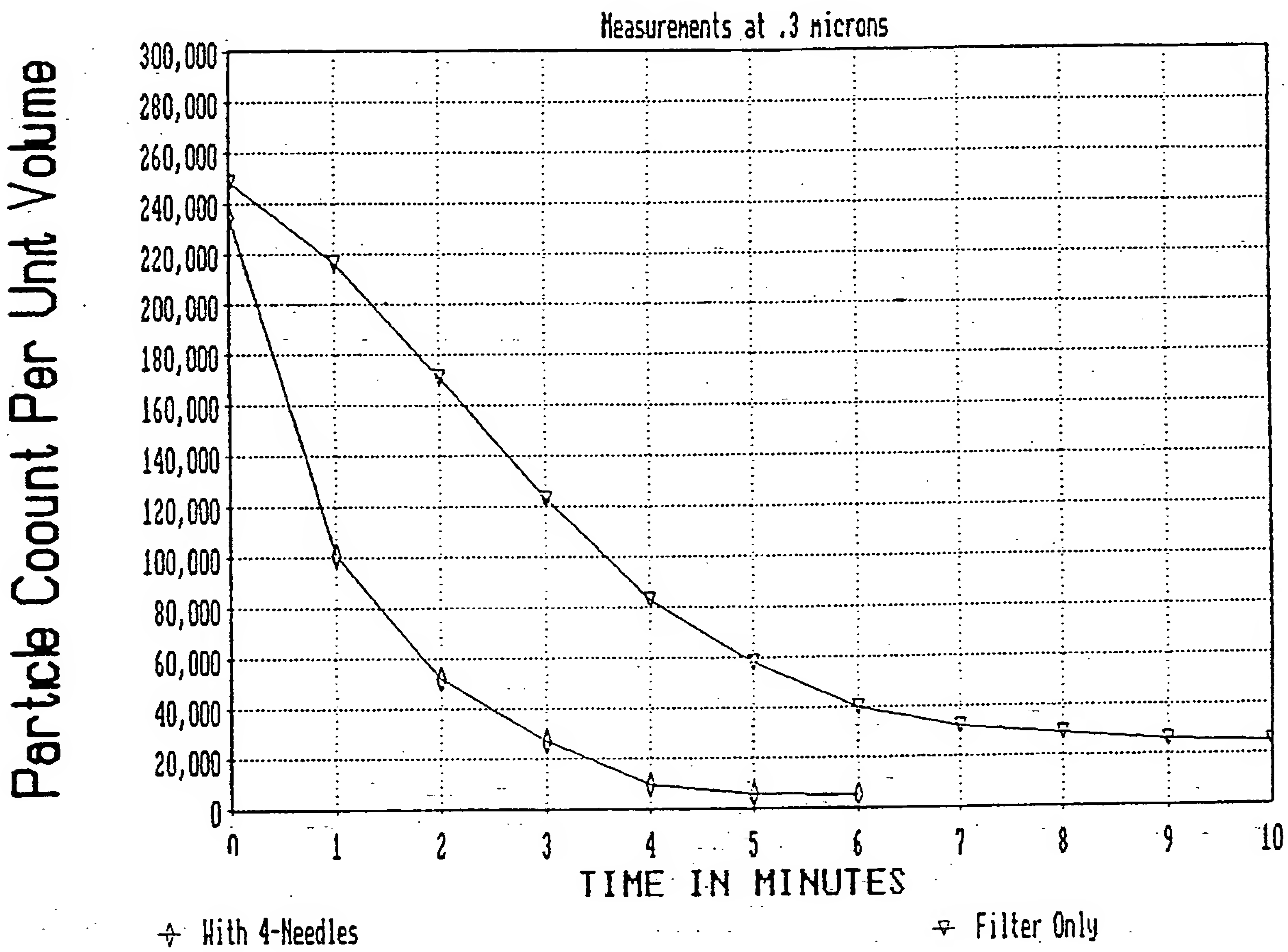

Fig 17

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 97/00833

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B03C3/155 B03C3/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B03C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 85 02792 A (NOZAKI MAKOTO;TERADA KIYOSHI; NOZAKI YOKO) 4 July 1985	1,5-8
A	see the whole document	9
X	L.B.TI ET AL: "Environmental Filter" IBM TECHNICAL DISCLOSURE BULLETIN., vol. 17, no. 9, February 1975, NEW YORK US, pages 2625-2626, XP002056412 see the whole document	1,11,25

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

1

Date of the actual completion of the international search	Date of mailing of the international search report
20 February 1998	06/03/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Decanniere, L

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int ional Application No
PCT/CA 97/00833

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 8502792 A	04-07-85	NONE	

Form PCT/ISA/210 (patent family annex) (July 1992)